SHUWA Ref.: P241469WO

DESCRIPTION

Title of Invention: METHOD FOR PRODUCING EQUOL AND 5-HYDROXYEQUOL, AND FERMENTED PRODUCT

Technical Field

[0001] The present disclosure relates to a method for producing equol and 5-hydroxyequol, and a fermented material containing equol and 5-hydroxyequol.

Background Art

[0002] Isoflavones, which are abundantly contained in leguminous plants, such as soybean, kudzu (*Pueraria lobata*), and the like, are one type of polyphenol and are flavonoids having an isoflavone as a basic backbone. Recent studies have revealed that isoflavones have female hormone activity (estrogen) and antioxidant activity, and that the ingestion of isoflavones has a preventive effect against breast cancer, prostate cancer, osteoporosis, hypercholesterolemia, heart disease, and menopausal disorders, for example (Non Patent Literatures 1 to 6).

[0003] Isoflavones contained in soybean contain glycosides condensed mainly with sugars and additionally contain isoflavone aglycones (hereinafter, also referred to as aglycones) which are not condensed with sugars. Examples of the isoflavones in the form of glycosides include daidzin, glycitin, and genistin.

These glycosides, when entering the human or animal body, are converted to aglycones daidzein, glycitein, and genistein, respectively, by the action of digestive enzymes or enzymes produced by enterobacteria (β-glucosidase and the like).

Among them, it is known that daidzein is enzymatically converted to equol through dihydrodaidzein by the action of enterobacteria. Likewise, it is known that genistein is also converted to 5-hydroxyequol through dihydrogenistein by the action of some enterobacteria (Non Patent Literature 7).

[0004] Equol is known to have the highest estrogenic activity among these metabolites (Non Patent Literatures 8 and 9), whereas 5-hydroxyequol also has estrogen-like activity and reportedly has 3-β-hydroxysteroid dehydrogenase inhibitory activity (Patent Literature 1); thus, these substances are expected to be utilized in the prevention or treatment of excess symptoms of aldosterone and glucocorticoid by inhibiting the biosynthesis of these hormones.

[0005] However, there are individual differences in the metabolism of isoflavones; it has been revealed that a limited number of people possess enterobacteria having the ability to ferment daidzein to produce equol as described above, and a proportion of those who possess such enterobacteria is about 50% in Japanese and about 30% in Europeans and Americans (Non Patent Literatures 10 and 11). It is considered that 5-hydroxyequol is produced by enzymes of equol-producing bacteria (Non Patent Literature 7). The enzymes involved in equol production from daidzein in the equol-producing bacteria are daidzein reductase (DZNR), dihydrodaidzein reductase (DHDR), and tetrahydrodaidzein reductase (THDR), and genes encoding these enzymes constitute clusters having a similar sequence and genetic configuration even among different equol-producing bacterial strains such as strains of the genus *Slackia*, the genus *Eggerthella*, and the genus *Lactococcus* (Non Patent Literature 12). Hence, *Slackia isoflavoniconvertens* DSM 22006 having enzymes involved in equol production, and intestinal lactic acid bacteria harboring a gene encoding each enzyme involved in equol production can produce equol and 5-hydroxyequol at the same time (Non Patent Literature 12).

[0006] People who do not possess enterobacteria producing equol or 5-hydroxyequol are not able to produce equol or 5-hydroxyequol in their bodies even when ingesting foods containing daidzein or genistein, such as soybean or the like. In order to solve these problems, an attempt has been made in recent years to produce equol using anaerobic microorganisms such as lactic acid bacteria, enterobacteria, and the

like (Patent Literatures 2 to 5), though no such approach has been reported on 5-hydroxyequol.

Citation List

Patent Literature

[0007]

Patent Literature 1: JP 2003-81875 A

Patent Literature 2: JP 2006-204296 A

Patent Literature 3: JP 2006-504409 T

Patent Literature 4: JP 2008-61584 A

Patent Literature 5: JP 2010-104241 A

Non Patent Literature

[0008]

Non Patent Literature 1: Adlercreutz, H., The Lancet Oncol., 3, 364-373 (2002)

Non Patent Literature 2: Duncan, A. M. et al., Best Pract. Res. Clin. Endocrinol. Metab., 17, 253-271 (2003)

Non Patent Literature 3: Wu, A. H. et al., Carcinogenesis, 23, 1491-1496 (2002)

Non Patent Literature 4: Yamamoto, S. et al., J. Natl. Cancer Inst., 95, 906-913 (2003)

Non Patent Literature 5: Onozawa, M. et al., Jpn. J. Cancer Res., 90, 393-398 (1999)

Non Patent Literature 6: Ridges, L. et al., Asia Pac. J. Clin. Nutr., 10, 204-211 (2001)

Non Patent Literature 7: Matthies, A. et al., Appl. Environ. Microbiol., 74 (15), 4847-52 (2008)

Non Patent Literature 8: Schmitt, E. et al., Toxicol. In Vitro, 15, 433-439 (2001)

Non Patent Literature 9: Sathyamoorthy, N. and Wang, T. T., Eur. J. Cancer, 33, 2384-2389 (1997)

Non Patent Literature 10: Arai, Y. et al., J. Epidemiol., 10, 127-135 (2000)

Non Patent Literature 11: Setchell, K. D. et al., J. Nutr., 133, 1027-1035 (2003)

Non Patent Literature 12: International Journal of Food Microbiology 360 (2021) 109328

Summary of Invention

Technical Problem

[0009] An object of the present disclosure is to provide at least a method for producing equol and 5-hydroxyequol, and a fermented material containing equol and 5-hydroxyequol.

Solution to Problem

[0010] The present disclosure is summarized as follows.

[1] A method for producing equol and 5-hydroxyequol using a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins, wherein

the daidzeins and the genisteins are present at the start of culture of the microorganism,

molar conversion efficiency from the genisteins to 5-hydroxyequol is 0.200%/h or more,

a molar concentration ratio of the genisteins to the daidzeins at the start of the culture is 1.500 or more or 0.500 or less,

the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and

the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof.

[2] The production method according to [1], wherein the molar conversion efficiency of the genisteins to 5-hydroxyequol is 0.250%/h or more.

[3] The production method according to [1] or [2], wherein the molar concentration ratio of the genisteins to the daidzeins is 1.800 or more or 0.400 or less.

[4] The production method according to any of [1] to [3], wherein the microorganism is one or more members selected from the group consisting of a microorganism belonging to the genus *Adlercreutzia*, a microorganism belonging to the genus *Asaccharobacter*, a microorganism belonging to the genus *Slackia*, and a microorganism belonging to the genus *Lactococcus*.

[5] The production method according to [4], wherein the microorganism is one or more members selected from the group consisting of a microorganism belonging to *Adlercreutzia equolifaciens*, a microorganism belonging to *Slackia equolifaciens*, and a microorganism belonging to *Lactococcus garvieae*.

[6] The production method according to any of [1] to [5], wherein β-cyclodextrin is further present at the start of culture of the microorganism.

[7] The production method according to any of [1] to [6], wherein Arginine is further present at the start of culture of the microorganism.

[8] A method for producing a fermented material containing equol and 5-hydroxyequol

by culturing a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins, wherein

the daidzeins and the genisteins are present at the start of culture of the microorganism,

a molar concentration ratio of the genisteins to the daidzeins at the start of the culture is 1.500 or more or 0.500 or less,

a total content of equol and 5-hydroxyequol in the fermented material is 0.5 mg/g or more and 100.0 mg/g or less per g dry weight,

the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and

the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof.

[9] The method according to [8], wherein the microorganism is one or more members selected from the group consisting of a microorganism belonging to the genus *Adlercreutzia*, a microorganism belonging to the genus *Asaccharobacter*, a microorganism belonging to the genus *Slackia*, and a microorganism belonging to the genus *Lactococcus*.

[10] The method according to [9], wherein the microorganism is one or more members selected from the group consisting of a microorganism belonging to *Adlercreutzia equolifaciens*, a microorganism belonging to *Slackia equolifaciens*, and a microorganism belonging to *Lactococcus garvieae*.

[11] The method according to any of [8] to [10], wherein β-cyclodextrin is further present at the start of culture of the microorganism.

[12] The method according to any of [8] to [11], wherein Arginine is further present at the start of culture of the microorganism.

[13] A method for producing equol and 5-hydroxyequol using a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins, wherein

the daidzeins and the genisteins are present at the start of culture of the microorganism,

molar conversion efficiency from the genisteins to 5-hydroxyequol is 0.150%/h or more,

a molar concentration ratio of the genisteins to the daidzeins at the start of the culture is 1.300 or more or 0.700 or less,

the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and

the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof.

[14] A method for producing a fermented material containing equol and 5-hydroxyequol

by culturing a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins, wherein

the daidzeins and the genisteins are present at the start of culture of the microorganism,

a molar concentration ratio of the genisteins to the daidzeins at the start of the culture is 1.300 or more or 0.700 or less,

a total content of equol and 5-hydroxyequol in the fermented material is 0.5 mg/g or more and 100.0 mg/g or less per g dry weight,

the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and

the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof.

[15] A method for producing an oral composition, comprising the step of incorporating

equol and 5-hydroxyequol,

in a base material, wherein

the equol and the 5-hydroxyequol are produced by the method according to any of [1] to [14].

[16] A method for producing a composition for a jelly beverage, comprising the step of incorporating

equol,

5-hydroxyequol,

collagen peptide, and

agar, wherein

the equol and the 5-hydroxyequol are produced by the method according to any of [1] to [14].

[17] The method for producing a composition for a jelly beverage according to [16], wherein

the equol is 0.01% by weight to 0.05% by weight

with respect to the total weight of the composition.

[18] A fermented material of a composition comprising daidzeins and genisteins, wherein

the fermented material contains equol and 5-hydroxyequol,

a total content of equol and 5-hydroxyequol in the fermented material is 0.5 mg/g or more and 100.0 mg/g or less per g dry weight,

a content of 5-hydroxyequol in the fermented material is 0.3 mg/g or more per g dry weight,

the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and

the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof.

[19] An oral composition comprising the fermented material according to [18] and a base material.

[20] A composition for a jelly beverage, comprising

the fermented material according to [18],

collagen peptide, and

agar.

[21] The composition for a jelly beverage according to [20], wherein

the equol is 0.01% by weight to 0.05% by weight

with respect to the total weight of the composition.

Advantageous Effects of Invention

[0011] The present disclosure can provide at least a method for producing equol and 5-hydroxyequol, and a fermented material containing equol and 5-hydroxyequol.

Further, the obtained equol and 5-hydroxyequol can be used in cosmetics, quasi-drugs, medical products, hygiene products, medicaments, foods and drinks (including supplements), and the like, for example, thereby allowing subjects including humans to conveniently obtain known effects brought about by equol and 5-hydroxyequol through use or ingestion thereof.

Brief Description of Drawing

[0012]

The figure is a diagram showing the relationship between a molar concentration ratio of genisteins to daidzeins at the start of culture and molar conversion efficiency of genisteins to 5-hydroxyequol.

Description of Embodiments

[0013] In the present disclosure, the description "XX or more and YY or less" or "XX to YY" which indicates a numerical range means a numerical range including the lower limit and the upper limit serving as end points, unless otherwise specified. When a numerical value is described at stages, individual numerical values or the upper and lower limits of the individual numerical values can be arbitrarily combined.

[0014] <Method for producing equol and 5-hydroxyequol>

A microorganism is preferably used in production. The microorganism is not particularly limited as long as the microorganism has the ability to produce equol (hereinafter, also referred to as EQ) from daidzeins, and the ability to produce 5-hydroxyequol (hereinafter, also referred to as 5HEQ) from genisteins. The microorganism may have an introduced gene encoding each enzyme involved in equol production and 5-hydroxyequol production (e.g., daidzein reductase (DZNR), dihydrodaidzein reductase (DHDR), tetrahydrodaidzein reductase (THDR), or the

like). The microorganism may further have the ability to produce ornithine from arginine.

A known microorganism, or a microorganism obtained through screening by a usual method can be used as the microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins. Examples thereof include microorganisms belonging to the genus *Coriobacterium*, microorganisms belonging to the genus *Adlercreutzia*, microorganisms belonging to the genus *Asaccharobacter*, microorganisms belonging to the genus *Atopobium*, microorganisms belonging to the genus *Bacteroides*, microorganisms belonging to the genus *Bifidibacterium*, microorganisms belonging to the genus *Clostridium*, microorganisms belonging to the genus *Collinsella*, microorganisms belonging to the genus *Cryptobacterium*, microorganisms belonging to the genus *Denitrobacterium*, microorganisms belonging to the genus *Eggerthella*, microorganisms belonging to the genus *Enterococcus*, microorganisms belonging to the genus *Enterorhabdus*, microorganisms belonging to the genus *Eubacterium*, microorganisms belonging to the genus *Finegoldia*, microorganisms belonging to the genus *Lactobacillus*, microorganisms belonging to the genus *Gordonibacter*, microorganisms belonging to the genus *Olsenella*, microorganisms belonging to the genus *Paraeggerthella*, microorganisms belonging to the genus *Pediococcus*, microorganisms belonging to the genus *Proteus*, microorganisms belonging to the genus *Sharpea*, microorganisms belonging to the genus *Slackia*, microorganisms belonging to the genus *Streptococcus*, microorganisms belonging to the genus *Veillonella*, microorganisms belonging to the genus *Lactococcus*, microorganisms belonging to the genus *Hugonella*, microorganisms belonging to the genus *Senegalimassilia*, and microorganisms obtained from these microorganisms through screening by a usual method with the ability to produce equol from daidzeins, and/or the ability to produce 5-hydroxyequol from genisteins as an index. The gene encoding each enzyme involved in equol production and 5-hydroxyequol production can be

obtained from, for example, a microorganism classified into the above genus or the like. Examples of the microorganism further having the ability to produce ornithine from arginine include lactic acid bacteria of the genus *Lactococcus*, the genus *Streptococcus*, and the like and more specifically include *Lactococcus garvieae*.

[0015] Further specific microorganisms are as follows.

- microorganisms belonging to *Adlercreutzia equolifaciens* such as *Adlercreutzia equolifaciens* subsp. *celatus* DSM 18785 strain, *Adlercreutzia equolifaciens* subsp. *equolifaciens* DSM 19450 strain, and the like;
- microorganisms belonging to *Bacteroides ovatus* such as *Bacteroides ovatus* E-23-15 strain (FERM BP-6435) and the like;
- microorganisms belonging to *Bifidibacterium breve* such as *Bifidibacterium breve* ATCC 15700 strain and the like;
- microorganisms belonging to *Bifidobacterium longum* such as *Bifidobacterium longum* NITE BP-02621 (ATCC BAA-999; BB536 strain) and the like;
- microorganisms belonging to the genus *Clostridium* such as *Clostridium* sp. HGH 136 strain (ATCC BAA-442) and the like;
- microorganisms belonging to the genus *Eggerthella* such as *Eggerthella* sp. Julong 732 strain (KCCM-10490), *Eggerthella* sp. YY7918 strain (the YY7918 strain is managed at the public agency Gifu Prefectural Institute of Biotechnology and can be obtained therefrom), *Eggerthella* sp. D1 strain, and the like;
- microorganisms belonging to *Enterococcus faecalis* such as *Enterococcus faecalis* INIA P333 strain and the like;
- microorganisms belonging to Enterococcus faecium such as *Enterococcus faecium* EPI1 strain and the like;
- microorganisms belonging to *Enterohabdus mucosicola* such as *Enterohabdus mucosicola* Mt1B8 strain (DSM 19490) and the like;
- microorganisms belonging to the genus *Eubacterium* such as *Eubacterium* sp. D2 strain and the like;

- microorganisms belonging to *Finegoldia magna* such as *Finegoldia magna* EPI3 strain and the like;
- microorganisms belonging to *Lactobacillus fermentum* such as *Lactobacillus fermentum* DPPMA114 strain (DSM 23757) and the like;
- microorganisms belonging to *Lactobacillus intestinalis* such as *Lactobacillus intestinalis* KTCT13676BP strain and the like;
- microorganisms belonging to *Lactobacillus mucosae* such as *Lactobacillus mucosae* EPI2 strain and the like;
- microorganisms belonging to *Lactobacillus paracasei* such as *Lactobacillus paracasei* JS1 strain and the like;
- microorganisms belonging to *Lactobacillus plantarum* such as *Lactobacillus plantarum* DPPMA24W strain (DSM 23756),
Lactobacillus plantarum DPPMASL33 strain (DSM 23755), and the like;
- microorganisms belonging to *Lactobacillus rhamnosus* such as *Lactobacillus rhamnosus* DPPMAAZ1 strain, *Lactobacillus rhamnosus* INIA P540 strain, and the like;
- microorganisms belonging to the genus *Lactobacillus* such as *Lactobacillus* sp. Niu-O16 strain and the like;
- microorganisms belonging to *Lactococcus garvieae* such as *Lactococcus garvieae* 20-92 strain (FERM BP-10036) and the like;
- microorganisms belonging to the genus *Paraeggerthella* such as *Paraeggerthella* sp. SNR40-432 strain and the like;
- microorganisms belonging to *Pediococcus pentosaceus* such as *Pediococcus pentosaceus* CS1 strain and the like;
- microorganisms belonging to *Proteus mirabilis* such as *Proteus mirabilis* LH-52 strain and the like;
- microorganisms belonging to *Sharpea azabuensis* such as *Sharpea azabuensis* ST18 strain (NITE P-300) and the like;

- microorganisms belonging to *Slackia equolifaciens* such as *Slackia equolifaciens* DSM 24851 strain and the like;
- microorganisms belonging to *Slackia isoflavoniconvertens* such as *Slackia isoflavoniconvertens* DSM 22006 strain and the like;
- microorganisms belonging to the genus *Slackia* such as *Slackia* sp. FJK1 strain (NITE P-1562), *Slackia* sp. NATTS strain (FERM BP-11231), *Slackia* sp. YIT11861 strain (FERM BP-11231), *Slackia* sp. TM-30 strain, and the like;
- microorganisms belonging to *Streptococcus constellatus* such as *Streptococcus constellatus* E-23-17 strain (FERM BP-6436) and the like;
- microorganisms belonging to *Streptococcus intermedius* such as *Streptococcus intermedius* A6G-225 strain (FERM BP-6437) and the like;
- microorganisms belonging to the genus *Veillonella* such as *Veillonella* sp. EP strain and the like;
- microorganisms belonging to *Hugonella massiliensis* such as *Hugonella massiliensis* DSM 101782T strain and the like; and
- microorganisms belonging to *Senegalimassilia faecalis* such as *Senegalimassilia faecalis* KGMB 04484T strain (KCTC 15721) and the like.

Other examples thereof include microorganisms retaining 16S rDNA of a nucleotide sequence having 95% or more, preferably 97% or more, more preferably 98% or more, further preferably 99% or more identity to the nucleotide sequence of 16S rDNA (16S rRNA gene) in these microorganisms. The microorganism may be a strain bred from a strain of each microorganism or a strain substantially equivalent thereto by mutation treatment, genetic recombination, selection of a natural mutant strain, or the like. One of these microorganisms may be used, or two or more thereof may be used.

The microorganism can be obtained from a depository described in deposition number. Each accession number means that the microorganism is deposited in the following depository.

FERM International Patent Organism Depositary (IPOD)

http://unit.aist.go.jp/pod/ci/index.html

DSM German Collection of Microorganisms and Cell Cultures (DSMZ)

http://www.dsmz.de/

KCCM Korean Culture Center of Microorganisms

KCTC Korean Collection for Type Cultures

ATCC American Type Culture Collection

NITE National Institute of Technology and Evaluation, Patent Microorganisms Depositary (NPMD)

[0016] In the method for producing equol and 5-hydroxyequol, genisteins such as genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, and the like are preferably used as a raw material for 5-hydroxyequol. Daidzeins such as daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, and the like are preferably used as a raw material for equol. The raw material is not particularly limited as long as the raw material contains genisteins or daidzeins. The raw material may contain, for example, glyciteins such as glycitin, malonylglycitin, acetylglycitin, glycitein, dihydroglycitein, and the like, in addition to the genisteins and the daidzeins. For example, soybean or soybean hypocotyl may be directly used as a raw material, or a defatted or deproteinized raw material may be used. Also, extracts of soybean or soybean hypocotyl, purified extracts of soybean or soybean hypocotyl, or the like may be used. Alternatively, tempeh, alfalfa, or extracts thereof may be used. When the microorganism has an enzyme that converts glycosides to aglycones, a raw material containing the daidzeins and the genisteins can be directly used; and when the microorganism has no enzyme that converts glycosides to aglycones, a raw material containing the daidzeins and the genisteins may be used after glycosides may be converted to aglycones by enzyme treatment or the like of the raw material.

[0017] The method for producing equol and 5-hydroxyequol is not particularly limited, and a heretofore known method is preferably used. Examples thereof include the culture of a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins, for example, using a composition containing daidzeins and genisteins serving as a raw material under conditions in which the daidzeins and the genisteins are present at the start of culture.

[0018] The composition containing daidzeins and genisteins is not particularly limited as long as the composition enables the microorganism having the ability to produce equol from daidzeins and the ability to produce 5-hydroxyequol from genisteins, to produce equol from the daidzeins and produce 5-hydroxyequol from the genisteins. The composition containing daidzeins and genisteins may contain a component other than the daidzeins and the genisteins as long as the composition enables the microorganism having the ability to produce equol from daidzeins and the ability to produce 5-hydroxyequol from genisteins, to produce equol from the daidzeins and produce 5-hydroxyequol from the genisteins. The composition containing daidzeins and genisteins may be a medium containing daidzeins and genisteins.

[0019] Anaerobic culture is carried out for an anaerobic microorganism, while aerobic culture is carried out for an aerobic microorganism. For example, in the case of an anaerobic microorganism, it is preferable to maintain gas phase conditions (anaerobic conditions) that permit its survival, and give the organism a nutrient for supporting the activity and proliferation of the anaerobic microorganism. Various medium formulations and gas phase conditions suitable for the survival of anaerobic microorganisms and the production of equol and/or 5-hydroxyequol are known. In short, a proper medium formulation and conditions for constituting the gas phase can be selected for each microorganism. Anaerobe basal broth (ABB) medium, GAM broth medium, modified GAM medium, BHI medium, or the like containing various

nutrients is preferably used as a medium. Various components given below may be appropriately contained in such a medium.

[0020] The medium may contain water-soluble organic materials including sugars such as sorbose, fructose, glucose, and the like; organic acids such as valeric acid, butyric acid, propionic acid, acetic acid, formic acid, and the like; and the like. The medium may also contain inorganic nitrogen sources including ammonium salts such as ammonium sulfate, ammonium chloride, ammonium phosphate, ammonium hydrogen phosphate, and the like; nitrates such as potassium nitrate, sodium nitrate, and the like; and the like, and organic nitrogen sources including amino acids such as arginine, citrulline, ornithine, lysine, and the like; yeast extracts, peptones, meat extracts, liver extracts, and digests of serum; and the like. The medium may further contain vitamins such as biotin, folic acid, pyridoxin, thiamin, riboflavin, nicotinic acid, pantothenic acid, vitamin B12, thioctic acid, p-aminobenzoic acid, and the like, a porphyrin compound hemin, and the like.

[0021] Arginine may be further present at the start of culture of the microorganism. Arginine may be further added to the composition containing daidzeins and genisteins at the start of culture of the microorganism. The amount of the arginine added to the composition containing daidzeins and genisteins is not particularly limited and may be 0.30 g/L or more, 0.40 g/L or more, 0.50 g/L or more, 0.60 g/L or more, 0.70 g/L or more, 0.80 g/L or more, 0.90 g/L or more, 1.00 g/L or more, 1.10 g/L or more, 1.20 g/L or more, 1.30 g/L or more, 1.40 g/L or more, 1.50 g/L or more, 1.60 g/L or more, 1.70 g/L or more, 1.80 g/L or more, 1.90 g/L or more, 2.00 g/L or more, 2.10 g/L or more, 2.20 g/L or more, 2.30 g/L or more, 2.40 g/L or more, 2.50 g/L or more, 2.60 g/L or more, 2.70 g/L or more, 2.80 g/L or more, 2.90 g/L or more, 3.00 g/L or more, 3.10 g/L or more, 3.20 g/L or more, 3.30 g/L or more, 3.40 g/L or more, 3.50 g/L or more, 3.60 g/L or more, 3.70 g/L or more, 3.80 g/L or more, 3.90 g/L or more, 4.00 g/L or more, 4.50 g/L or more, or 5.00 g/L or more. The upper limit thereof is not particularly limited and may be 10.00 g/L or less, 9.00 g/L or less,

8.00 g/L or less, or 7.00 g/L or less. Specifically, the amount may be, for example, 0.30 g/L to 10.00 g/L, 0.40 g/L to 9.00 g/L, 0.50 g/L to 8.00 g/L, or 0.60 g/L to 7.00 g/L.

[0022] Cyclodextrin may be further present at the start of culture of the microorganism. Cyclodextrin may be further added to the composition containing daidzeins and genisteins at the start of culture of the microorganism. Examples of the cyclodextrin include α-cyclodextrin, β-cyclodextrin, γ-cyclodextrin, and their derivatives glycosyl-cyclodextrin, maltosyl-cyclodextrin, hydroxypropyl-cyclodextrin, and methyl-cyclodextrin, and the like. One of these cyclodextrins may be used, or two or more thereof may be used. The amount of the cyclodextrin added to the composition containing daidzeins and genisteins is not particularly limited and may be 0.01 g/L or more, 0.05 g/L or more, 0.1 g/L or more, 0.2 g/L or more, 0.3 g/L or more, 0.4 g/L or more, 0.5 g/L or more, 0.6 g/L or more, 0.7 g/L or more, 0.8 g/L or more, 0.9 g/L or more, 1.0 g/L or more, 1.5 g/L or more, 2.0 g/L or more, 2.5 g/L or more, 3.0 g/L or more, 3.5 g/L or more, 4.0 g/L or more, 4.5 g/L or more, 5.0 g/L or more, 5.5 g/L or more, 6.0 g/L or more, 6.5 g/L or more, 7.0 g/L or more, 7.5 g/L or more, 8.0 g/L or more, 8.5 g/L or more, 9.0 g/L or more, 9.5 g/L or more, 10.0 g/L or more, 10.5 g/L or more, 11.0 g/L or more, 11.5 g/L or more, 12.0 g/L or more, 12.5 g/L or more, 13.0 g/L or more, 13.5 g/L or more, 14.0 g/L or more, 14.5 g/L or more, 15.0 g/L or more, 15.5 g/L or more, 16.0 g/L or more, 16.5 g/L or more, 17.0 g/L or more, or 17.5 g/L or more. The upper limit thereof is not particularly limited and is preferably set to be equal to or less than the solubility of dextrin at a culture temperature. For example, for β-cyclodextrin, the amount is preferably set to 30.5 g/L or less.

[0023] The medium can be liquid, semi-solid, or solid. It is preferable to appropriately select the content of each component contained in the medium so as to meet the growth of the microorganism and the production of the substances of interest.

[0024] In the culture of an anaerobic microorganism, the combination of gases to be supplied to an aqueous phase or to constitute a gas phase is not particularly limited, and a mixed gas containing one or more types selected from hydrogen, carbon dioxide, nitrogen, and the like as constituents is preferably used. The mixed gas preferably contains hydrogen as a constituent. A method for creating an environment suitable for culture in the gas phase or the aqueous phase during culture is not particularly limited, and it is preferable to adopt, for example, a method such as the purging of the gas phase with the mixed gas before culture, the supply of the mixed gas from the bottom of a culture apparatus even during culture, the supply of the mixed gas to the gas phase in a culture apparatus, the bubbling of the aqueous phase with the mixed gas before culture, or the like. Hydrogen gas may be directly used as hydrogen, or hydrogen may be produced during culture by the action of the microorganism by adding a hydrogen precursor such as formic acid or the like to the medium.

[0025] When hydrogen is contained as a constituent, the percent concentration by partial pressure of hydrogen in the mixed gas can be 0.1% to 100%. The percent concentration by partial pressure can be, for example, 0.1%, 1%, 2%, 4%, 6%, 10%, 20%, 30%, 40%, 50%, 80%, or 100%, or can be indicated by a concentration range having two percent concentrations by partial pressure selected therefrom as the lower limit and the upper limit. Specifically, the percent concentration by partial pressure of hydrogen in the mixed gas can be, for example, 0.1% to 100%, 1% to 80%, 2% to 50%, 4% to 40%, 6% to 30%, or 10% to 20%.

[0026] In the case of aerating a culture apparatus with the mixed gas in culture, the amount of the mixed gas used in the aeration is not particularly limited and is preferably adjusted to on the order of 0.005 V/V/M (gas volume/liquid volume/min) to 2.0 V/V/M (gas volume/liquid volume/min). Pressure conditions can be set to the range of 0.01 MPa to 0.5 MPa, though the conditions are not particularly limited as long as the microorganism can grow and produce substances under the condition.

[0027] A culture temperature or culture pH is not particularly limited and is preferably a temperature or pH that meets the growth and substance production of each microorganism. In general, the temperature can be on the order of 30°C to 42°C, and may be, for example, 30°C or higher, 31°C or higher, 32°C or higher, 33°C or higher, or 34°C or higher and may be 42°C or lower, 41°C or lower, 40°C or lower, or 39°C or lower. Specifically, the temperature may be, for example, 30°C to 42°C, 31°C to 41°C, 32°C to 40°C, 33°C to 39°C, or 34°C to 39°C.

The pH can be 3.0 to 9.0, and may be, for example, 3.0 or higher, 4.0 or higher, 5.0 or higher, 6.0 or higher, 6.1 or higher, 6.2 or higher, 6.3 or higher, 6.4 or higher, 6.5 or higher, 6.6 or higher, 6.7 or higher, or 6.8 or higher and may be 9.0 or lower, 8.5 or lower, 8.4 or lower, 8.3 or lower, 8.2 or lower, 8.1 or lower, 7.5 or lower, or 7.0 or lower. Specifically, the pH may be, for example, 3.0 to 9.0, 4.0 to 8.5, 5.0 to 8.4, 6.0 to 8.3, 6.1 to 8.2, or 6.2 to 8.1.

[0028] A culture time is not particularly limited and is usually on the order of 6 hours to 340 hours. The culture time may be, for example, 6 hours or longer, 8 hours or longer, 9 hours or longer, 10 hours or longer, 11 hours or longer, 12 hours or longer, 13 hours or longer, 14 hours or longer, 15 hours or longer, 16 hours or longer, 17 hours or longer, 18 hours or longer, 19 hours or longer, 20 hours or longer, 25 hours or longer, 30 hours or longer, 35 hours or longer, 40 hours or longer, or 45 hours or longer. The upper limit can be appropriately set depending on a purpose and may be 340 hours or shorter, 300 hours or shorter, 250 hours or shorter, 200 hours or shorter, 150 hours or shorter, 140 hours or shorter, 130 hours or shorter, 120 hours or shorter, 110 hours or shorter, 100 hours or shorter, 95 hours or shorter, 90 hours or shorter, 85 hours or shorter, 80 hours or shorter, 75 hours or shorter, 70 hours or shorter, 65 hours or shorter, 60 hours or shorter, 55 hours or shorter, 50 hours or shorter, 45 hours or shorter, 40 hours or shorter, 35 hours or shorter, 30 hours or shorter, or 25 hours or shorter. Specifically, the culture time may be, for example, 6 hours to 340 hours, 8 hours to 300 hours, 9 hours to 250 hours, 10 hours to 200

hours, 11 hours to 150 hours, 12 hours to 140 hours, 13 hours to 130 hours, 14 hours to 120 hours, 15 hours to 110 hours, 16 hours to 100 hours, 17 hours to 95 hours, 18 hours to 90 hours, 19 hours to 85 hours, 20 hours to 80 hours, 25 hours to 75 hours, 30 hours to 70 hours, 35 hours to 65 hours, 40 hours to 60 hours, or 45 hours to 55 hours.

[0029] The molar conversion rate of the genisteins to 5-hydroxyequol may be 10.0% or more. The phrase "molar conversion rate of the genisteins to 5-hydroxyequol is 10.0% or more" may mean that the culture of the microorganism having the ability to produce equol from daidzein, and the ability to produce 5-hydroxyequol from genistein is started under conditions in which the daidzeins and the genisteins are present, and the microorganism is cultured until the molar conversion rate of the genisteins to 5-hydroxyequol reaches at least 10.0%.

The molar conversion rate of the genisteins to 5-hydroxyequol may be 10.0% or more, 11.0% or more, 12.0% or more, 13.0% or more, 14.0% or more, 15.0% or more, 16.0% or more, 18.0% or more, 20.0% or more, 22.0% or more, 24.0% or more, 26.0% or more, 28.0% or more, 30.0% or more, 32.0% or more, 34.0% or more, 36.0% or more, 38.0% or more, 40.0% or more, 42.0% or more, 44.0% or more, 46.0% or more, 48.0% or more, 50.0% or more, 52.0% or more, 54.0% or more, 56.0% or more, 58.0% or more, 60.0% or more, 62.0% or more, 64.0% or more, 66.0% or more, 68.0% or more, 70.0% or more, 72.0% or more, 74.0% or more, 76.0% or more, 78.0% or more, or 80.0% or more, and the upper limit is not particularly limited and may be 100.0% or less, 98.0% or less, 96.0% or less, 94.0% or less, 92.0% or less, or 90.0% or less. Specifically, the molar conversion rate may be, for example, 10.0% to 100.0%, 11.0% to 98.0%, 12.0% to 96.0%, 13.0% to 94.0%, 14.0% to 92.0%, or 15.0% to 90.0%.

[0030] The molar conversion rate of the genisteins to 5-hydroxyequol for 30 hours, 29 hours, 28 hours, 27 hours, 26 hours, 25 hours, 24 hours, 23 hours, 22 hours, 21 hours, 20 hours, 19 hours, 18 hours, 17 hours, 16 hours, 15 hours, 14 hours, 13 hours,

12 hours, 11 hours, or 10 hours from the start of culture may be less than 10.0%. The molar conversion rate of the genisteins to 5-hydroxyequol for 30 hours, 29 hours, 28 hours, 27 hours, 26 hours, 25 hours, 24 hours, 23 hours, 22 hours, 21 hours, 20 hours, 19 hours, 18 hours, 17 hours, 16 hours, 15 hours, 14 hours, 13 hours, 12 hours, 11 hours, or 10 hours from the start of culture may be 9.0% or less, 8.0% or less, 7.0% or less, 6.0% or less, 5.0% or less, 4.0% or less, 3.0% or less, 2.0% or less, or 1.0% or less. The molar conversion rate of the genisteins to 5-hydroxyequol for 30 hours, 29 hours, 28 hours, 27 hours, 26 hours, 25 hours, 24 hours, 23 hours, 22 hours, 21 hours, 20 hours, 19 hours, 18 hours, 17 hours, 16 hours, 15 hours, 14 hours, 13 hours, 12 hours, 11 hours, or 10 hours from the start of culture may be 0%.

[0031] The molar conversion rate of the daidzeins to equol may be 10.0% or more. The phrase "molar conversion rate of the daidzeins to equol is 10.0% or more" may mean that the culture of the microorganism having the ability to produce equol from daidzein, and the ability to produce 5-hydroxyequol from genistein is started under conditions in which the daidzeins and the genisteins are present, and the microorganism is cultured until the molar conversion rate of the daidzeins to equol reaches at least 10.0%.

The molar conversion rate of the daidzeins to equol may be 10.0% or more, 11.0% or more, 12.0% or more, 13.0% or more, 14.0% or more, 15.0% or more, 16.0% or more, 18.0% or more, 20.0% or more, 22.0% or more, 24.0% or more, 26.0% or more, 28.0% or more, 30.0% or more, 32.0% or more, 34.0% or more, 36.0% or more, 38.0% or more, 40.0% or more, 42.0% or more, 44.0% or more, 46.0% or more, 48.0% or more, 50.0% or more, 52.0% or more, 54.0% or more, 56.0% or more, 58.0% or more, 60.0% or more, 62.0% or more, 64.0% or more, 66.0% or more, 68.0% or more, 70.0% or more, 72.0% or more, 74.0% or more, 76.0% or more, 78.0% or more, or 80.0% or more, and the upper limit is not particularly limited and may be 100.0% or less, 98.0% or less, 96.0% or less, 94.0% or less, 92.0% or less, or 90.0% or less. Specifically, the molar conversion rate may

be, for example, 10.0% to 100.0%, 11.0% to 98.0%, 12.0% to 96.0%, 13.0% to 94.0%, 14.0% to 92.0%, or 15.0% to 90.0%.

[0032] The molar conversion rate of the daidzeins to equol for 30 hours, 29 hours, 28 hours, 27 hours, 26 hours, 25 hours, 24 hours, 23 hours, 22 hours, 21 hours, 20 hours, 19 hours, 18 hours, 17 hours, 16 hours, 15 hours, 14 hours, 13 hours, 12 hours, 11 hours, or 10 hours from the start of culture may be less than 10.0%. The molar conversion rate of the daidzeins to equol for 30 hours, 29 hours, 28 hours, 27 hours, 26 hours, 25 hours, 24 hours, 23 hours, 22 hours, 21 hours, 20 hours, 19 hours, 18 hours, 17 hours, 16 hours, 15 hours, 14 hours, 13 hours, 12 hours, 11 hours, or 10 hours from the start of culture may be 9.0% or less, 8.0% or less, 7.0% or less, 6.0% or less, 5.0% or less, 4.0% or less, 3.0% or less, 2.0% or less, or 1.0% or less. The molar conversion rate of the daidzeins to equol for 30 hours, 29 hours, 28 hours, 27 hours, 26 hours, 25 hours, 24 hours, 23 hours, 22 hours, 21 hours, 20 hours, 19 hours, 18 hours, 17 hours, 16 hours, 15 hours, 14 hours, 13 hours, 12 hours, 11 hours, or 10 hours from the start of culture may be 0%.

[0033] The molar conversion efficiency of the genisteins to 5-hydroxyequol may be, for example, 0.150 (%/h) or more, or may be 0.200 (%/h) or more. The phrase "molar conversion efficiency of the genisteins to 5-hydroxyequol is 0.150 (%/h) or more" may mean that the culture of the microorganism having the ability to produce equol from daidzein, and the ability to produce 5-hydroxyequol from genistein is started under conditions in which the daidzeins and the genisteins are present, and the microorganism is cultured until the molar conversion efficiency of the genisteins to 5-hydroxyequol reaches at least 0.150 (%/h). The molar conversion efficiency is a numerical value (unit: "%/h") determined by dividing the molar conversion rate (%) by a time required for culture (unit: "h"; also referred to as a culture time).

[0034] The molar conversion efficiency of the genisteins to 5-hydroxyequol may be 0.120 (%/h) or more, 0.130 (%/h) or more, 0.140 (%/h) or more, 0.150 (%/h) or more, 0.160 (%/h) or more, 0.170 (%/h) or more, 0.180 (%/h) or more, 0.190 (%/h)

or more, 0.200 (%/h) or more, 0.210 (%/h) or more, 0.220 (%/h) or more, 0.230 (%/h) or more, 0.250 (%/h) or more, 0.300 (%/h) or more, 0.350 (%/h) or more, 0.400 (%/h) or more, 0.450 (%/h) or more, 0.500 (%/h) or more, 0.550 (%/h) or more, 0.600 (%/h) or more, 0.650 (%/h) or more, 0.700 (%/h) or more, 0.750 (%/h) or more, 0.800 (%/h) or more, 0.850 (%/h) or more, 0.900 (%/h) or more, 0.950 (%/h) or more, 1.000 (%/h) or more, 1.050 (%/h) or more, 1.100 (%/h) or more, 1.150 (%/h) or more, 1.200 (%/h) or more, 1.250 (%/h) or more, 1.300 (%/h) or more, 1.350 (%/h) or more, 1.400 (%/h) or more, 1.450 (%/h) or more, 1.500 (%/h) or more, 1.550 (%/h) or more, 1.600 (%/h) or more, 1.650 (%/h) or more, 1.700 (%/h) or more, 1.750 (%/h) or more, 1.800 (%/h) or more, 1.850 (%/h) or more, 1.900 (%/h) or more, 1.950 (%/h) or more, or 2.000 (%/h) or more, and the upper limit is not particularly limited and may be 10.000 (%/h) or less, 9.000 (%/h) or less, 8.000 (%/h) or less, 7.000 (%/h) or less, 6.000 (%/h) or less, or 5.000 (%/h) or less. Specifically, the molar conversion efficiency may be, for example, 0.120 (%/h) to 10.000 (%/h), 0.130 (%/h) to 9.000 (%/h), 0.140 (%/h) to 8.000 (%/h), 0.150 (%/h) to 7.000 (%/h), 0.160 (%/h) to 6.000 (%/h), or 0.170 (%/h) to 5.000 (%/h).

[0035] The molar conversion efficiency of the daidzeins to equol may be, for example, 0.200 (%/h) or more. The phrase "molar conversion efficiency of the daidzeins to equol is 0.200 (%/h) or more" may mean that the culture of the microorganism having the ability to produce equol from daidzein, and the ability to produce 5-hydroxyequol from genistein is started under conditions in which the daidzeins and the genisteins are present, and the microorganism is cultured until the molar conversion efficiency of the daidzeins to equol reaches at least 0.200 (%/h).

The molar conversion efficiency of the daidzeins to equol may be 0.120 (%/h) or more, 0.130 (%/h) or more, 0.140 (%/h) or more, 0.150 (%/h) or more, 0.160 (%/h) or more, 0.170 (%/h) or more, 0.180 (%/h) or more, 0.190 (%/h) or more, 0.200 (%/ h) or more, 0.210 (%/h) or more, 0.220 (%/h) or more, 0.230 (%/h) or more, 0.250 (%/h) or more, 0.300 (%/h) or more, 0.350 (%/h) or more, 0.400 (%/h)

or more, 0.450 (%/h) or more, 0.500 (%/h) or more, 0.550 (%/h) or more, 0.600 (%/h) or more, 0.650 (%/h) or more, 0.700 (%/h) or more, 0.750 (%/h) or more, 0.800 (%/h) or more, 0.850 (%/h) or more, 0.900 (%/h) or more, 0.950 (%/h) or more, 1.000 (%/h) or more, 1.050 (%/h) or more, 1.100 (%/h) or more, 1.150 (%/h) or more, 1.200 (%/h) or more, 1.250 (%/h) or more, 1.300 (%/h) or more, 1.350 (%/h) or more, 1.400 (%/h) or more, 1.450 (%/h) or more, 1.500 (%/h) or more, 1.550 (%/h) or more, 1.600 (%/h) or more, 1.650 (%/h) or more, 1.700 (%/h) or more, 1.750 (%/ h) or more, 1.800 (%/h) or more, 1.850 (%/h) or more, 1.900 (%/h) or more, 1.950 (%/h) or more, 2.000 (%/h) or more, 2.050 (%/h) or more, 2.100 (%/h) or more, 2.150 (%/h) or more, or 2.200 (%/h) or more, and the upper limit is not particularly limited and may be 10.000 (%/h) or less, 9.000 (%/h) or less, 8.000 (%/h) or less, 7.000 (%/h) or less, 6.000 (%/h) or less, or 5.000 (%/h) or less. Specifically, the molar conversion efficiency may be, for example, 0.120 (%/h) to 10.000 (%/h), 0.130 (%/h) to 9.000 (%/h), 0.140 (%/h) to 8.000 (%/h), 0.150 (%/h) to 7.000 (%/h), 0.160 (%/h) to 6.000 (%/h), or 0.170 (%/h) to 5.000 (%/h).

[0036] When the molar conversion efficiency of the genisteins to 5-hydroxyequol reaches 0.120 (%/h) or more, 0.130 (%/h) or more, 0.140 (%/h) or more, 0.150 (%/h) or more, 0.160 (%/h) or more, 0.170 (%/h) or more, 0.180 (%/h) or more, 0.190 (%/h) or more, 0.200 (%/h) or more, 0.210 (%/h) or more, 0.220 (%/ h) or more, 0.230 (%/h) or more, 0.250 (%/h) or more, 0.300 (%/h) or more, 0.350 (%/h) or more, 0.400 (%/h) or more, 0.450 (%/h) or more, 0.500 (%/h) or more, 0.550 (%/h) or more, 0.600 (%/h) or more, 0.650 (%/h) or more, 0.700 (%/h) or more, 0.750 (%/h) or more, 0.800 (%/h) or more, 0.850 (%/h) or more, 0.900 (%/h) or more, 0.950 (%/h) or more, 1.000 (%/h) or more, 1.050 (%/h) or more, 1.100 (%/h) or more, 1.150 (%/h) or more, 1.200 (%/h) or more, 1.250 (%/h) or more, 1.300 (%/h) or more, 1.350 (%/h) or more, 1.400 (%/h) or more, 1.450 (%/h) or more, 1.500 (%/h) or more, 1.550 (%/h) or more, 1.600 (%/h) or more, 1.650 (%/h) or more, 1.700 (%/h) or more, 1.750 (%/h) or more, 1.800 (%/h) or more, 1.850 (%/ h) or

more, 1.900 (%/h) or more, 1.950 (%/h) or more, or 2.000 (%/h) or more, the molar conversion efficiency of the daidzeins to equol may be 0.120 (%/h) or more, 0.130 (%/h) or more, 0.140 (%/h) or more, 0.150 (%/h) or more, 0.160 (%/h) or more, 0.170 (%/h) or more, 0.180 (%/h) or more, 0.190 (%/h) or more, 0.200 (%/h) or more, 0.210 (%/h) or more, 0.220 (%/h) or more, 0.230 (%/h) or more, 0.250 (%/h) or more, 0.300 (%/h) or more, 0.350 (%/h) or more, 0.400 (%/h) or more, 0.450 (%/h) or more, 0.500 (%/h) or more, 0.550 (%/h) or more, 0.600 (%/h) or more, 0.650 (%/h) or more, 0.700 (%/h) or more, 0.750 (%/h) or more, 0.800 (%/h) or more, 0.850 (%/h) or more, 0.900 (%/h) or more, 0.950 (%/h) or more, 1.000 (%/h) or more, 1.050 (%/h) or more, 1.100 (%/h) or more, 1.150 (%/h) or more, 1.200 (%/h) or more, 1.250 (%/h) or more, 1.300 (%/h) or more, 1.350 (%/h) or more, 1.400 (%/h) or more, 1.450 (%/h) or more, 1.500 (%/h) or more, 1.550 (%/h) or more, 1.600 (%/h) or more, 1.650 (%/h) or more, 1.700 (%/h) or more, 1.750 (%/h) or more, 1.800 (%/h) or more, 1.850 (%/h) or more, 1.900 (%/h) or more, 1.950 (%/h) or more, 2.000 (%/h) or more, 2.050 (%/h) or more, 2.100 (%/h) or more, 2.150 (%/h) or more, or 2.200 (%/h) or more and may be 10.000 (%/h) or less, 9.000 (%/h) or less, 8.000 (%/h) or less, 7.000 (%/h) or less, 6.000 (%/h) or less, or 5.000 (%/h) or less. Specifically, the molar conversion efficiency may be, for example, 0.120 (%/h) to 10.000 (%/h), 0.130 (%/h) to 9.000 (%/h), 0.140 (%/h) to 8.000 (%/h), 0.150 (%/h) to 7.000 (%/h), 0.160 (%/h) to 6.000 (%/h), or 0.170 (%/h) to 5.000 (%/h).

[0037] The molar concentration ratio of the genisteins to the daidzeins, i.e., a value determined by dividing the "molar concentration of the genisteins" by the "molar concentration of the daidzeins", at the start of culture (or fermentation) may be 1.000 or more, 1.100 or more, 1.200 or more, 1.300 or more, 1.400 or more, 1.500 or more, 1.600 or more, 1.700 or more, 1.800 or more, 1.900 or more, 2.000 or more, 3.000 or more, 4.000 or more, or 5.000 or more and may be 1000.000 or less, 500.000 or less, 100.00 or less, 50.000 or less, 40.000 or less, 30.000 or less, 20.000 or less, 15.000 or

less, 10.000 or less, 7.000 or less, or 5.000 or less. Specifically, the molar concentration ratio may be, for example, 1.000 to 1000.000, 1.100 to 500.000, 1.200 to 100.00, 1.300 to 100.00, 1.400 to 50.000, 1.500 to 40.000, 1.600 to 30.000, 1.700 to 20.000, 1.800 to 15.000, 1.900 to 10.000, 2.000 to 7.000, or 3.000 to 5.000.

Alternatively, the molar concentration ratio may be 0.900 or less, 0.800 or less, 0.750 or less, 0.740 or less, 0.730 or less, 0.720 or less, 0.710 or less, 0.700 or less, 0.690 or less, 0.680 or less, 0.670 or less, 0.660 or less, 0.650 or less, 0.640 or less, 0.630 or less, 0.620 or less, 0.610 or less, 0.600 or less, 0.590 or less, 0.580 or less, 0.570 or less, 0.560 or less, 0.550 or less, 0.540 or less, 0.530 or less, 0.520 or less, 0.510 or less, 0.500 or less, 0.490 or less, 0.480 or less, 0.470 or less, 0.460 or less, 0.450 or less, 0.440 or less, 0.430 or less, 0.420 or less, 0.410 or less, 0.400 or less, 0.390 or less, 0.380 or less, 0.370 or less, 0.360 or less, 0.350 or less, 0.340 or less, 0.330 or less, 0.320 or less, 0.310 or less, 0.300 or less, 0.250 or less, 0.200 or less, 0.180 or less, 0.170 or less, 0.160 or less, 0.150 or less, 0.140 or less, 0.130 or less, 0.120 or less, 0.110 or less, 0.100 or less, 0.090 or less, 0.080 or less, 0.070 or less, 0.060 or less, 0.050 or less, 0.040 or less, 0.030 or less, 0.020 or less, 0.010 or less, 0.006 or less, 0.005 or less, 0.004 or less, or 0.003 or less and may be 0.0001 or more, 0.0005 or more, 0.001 or more, or 0.002 or more. Specifically, the molar concentration ratio may be, for example, 0.0001 to 0.900, 0.0005 to 0.800, 0.001 to 0.750, 0.001 to 0.700, 0.002 to 0.600, or 0.002 to 0.700.

[0038] In the composition containing daidzeins and genisteins, the total content of the daidzeins and the genisteins at the start of culture (or fermentation) is not particularly limited. The total content may be, for example, 0.01 mM or more, 0.02 mM or more, 0.05 mM or more, 0.10 mM or more, 0.50 mM or more, 1.00 mM or more, 1.50 mM or more, 2.00 mM or more, 2.50 mM or more, 3.00 mM or more, 3.50 mM or more, 4.00 mM or more, 4.50 mM or more, 5.00 mM or more, 5.50 mM or more, 6.00 mM or more, 6.50 mM or more, 7.00 mM or more, 7.50 mM or more, 8.00 mM or more, 8.50 mM or more, 9.00 mM or more, 9.50 mM or more, 10.00

mM or more, 10.50 mM or more, 11.00 mM or more, 11.50 mM or more, 12.00 mM or more, 12.50 mM or more, 13.00 mM or more, 13.50 mM or more, 14.00 mM or more, 14.50 mM or more, 15.00 mM or more, 15.50 mM or more, 16.00 mM or more, 16.50 mM or more, or 17.00 mM or more. The upper limit thereof is not particularly limited and may be, for example, 400.00 mM or less, 300.00 mM or less, 200.00 mM or less, 100.00 mM or less, 50.00 mM or less, 40.00 mM or less, 30.00 mM or less, or 20.00 mM or less. Specifically, the total content may be, for example, 0.01 mM to 400.00 mM, 0.02 mM to 300.00 mM, 0.05 mM to 200.00 mM, 0.10 mM to 100.00 mM, 0.50 mM to 50.00 mM, 1.00 mM to 40.00 mM, 1.50 mM to 30.00 mM, 2.00 mM to 30.00 mM, or 2.50 mM to 20.00 mM.

[0039] In the composition containing daidzeins and genisteins, the content of the daidzein at the start of culture (or fermentation) is not particularly limited. The content may be, for example, 0.01 mM or more, 0.02 mM or more, 0.05 mM or more, 0.10 mM or more, 0.50 mM or more, 0.60 mM or more, 0.70 mM or more, 0.80 mM or more, 0.90 mM or more, 1.00 mM or more, 1.50 mM or more, 2.00 mM or more, 2.50 mM or more, 3.00 mM or more, 3.50 mM or more, 4.00 mM or more, 4.50 mM or more, 5.00 mM or more, 5.50 mM or more, 6.00 mM or more, 6.50 mM or more, 7.00 mM or more, 7.50 mM or more, 8.00 mM or more, 8.50 mM or more, 9.00 mM or more, 9.50 mM or more, 10.00 mM or more, 10.50 mM or more, 11.00 mM or more, 11.50 mM or more, 12.00 mM or more, 12.50 mM or more, 13.00 mM or more, 13.50 mM or more, 14.00 mM or more, 14.50 mM or more, 15.00 mM or more, 15.50 mM or more, 16.00 mM or more, 16.50 mM or more, or 17.00 mM or more. The upper limit thereof is not particularly limited and may be, for example, 400.00 mM or less, 300.00 mM or less, 200.00 mM or less, 100.00 mM or less, 50.00 mM or less, 40.00 mM or less, 30.00 mM or less, or 20.00 mM or less. Specifically, the content may be, for example, 0.01 mM to 400.00 mM, 0.02 mM to 300.00 mM, 0.05 mM to 200.00 mM, 0.10 mM to 100.00 mM, 0.50 mM to 50.00 mM, 0.60 mM to 40.00 mM, 1.00 mM to 40.00 mM, 0.70 mM to 30.00 mM, 0.80

mM to 30.00 mM, 1.50 mM to 30.00 mM, 2.00 mM to 30.00 mM, 0.90 mM to 20.00 mM, or 2.50 mM to 20.00 mM.

[0040] In the composition containing daidzeins and genisteins, the content of the genistein at the start of culture (or fermentation) is not particularly limited. The content may be, for example, 0.01 mM or more, 0.02 mM or more, 0.05 mM or more, 0.10 mM or more, 0.50 mM or more, 0.60 mM or more, 0.70 mM or more, 0.80 mM or more, 0.90 mM or more, 1.00 mM or more, 1.50 mM or more, 2.00 mM or more, 2.50 mM or more, 3.00 mM or more, 3.50 mM or more, 4.00 mM or more, 4.50 mM or more, 5.00 mM or more, 5.50 mM or more, 6.00 mM or more, 6.50 mM or more, 7.00 mM or more, 7.50 mM or more, 8.00 mM or more, 8.50 mM or more, 9.00 mM or more, 9.50 mM or more, 10.00 mM or more, 10.50 mM or more, 11.00 mM or more, 11.50 mM or more, 12.00 mM or more, 12.50 mM or more, 13.00 mM or more, 13.50 mM or more, 14.00 mM or more, 14.50 mM or more, 15.00 mM or more, 15.50 mM or more, 16.00 mM or more, 16.50 mM or more, or 17.00 mM or more. The upper limit thereof is not particularly limited and may be, for example, 400.00 mM or less, 300.00 mM or less, 200.00 mM or less, 100.00 mM or less, 50.00 mM or less, 40.00 mM or less, 30.00 mM or less, 20.00 mM or less, 10.00 mM or less, 5.00 mM or less, or 1.00 mM or less. The lower limit and the upper limit may be combined so as not to contradict each other. Specifically, the content may be, for example, 0.01 mM to 400.00 mM, 0.02 mM to 300.00 mM, 0.05 mM to 200.00 mM, 0.10 mM to 100.00 mM, 0.50 mM to 50.00 mM, 0.60 mM to 40.00 mM, 1.00 mM to 40.00 mM, 0.70 mM to 30.00 mM, 1.50 mM to 30.00 mM, 0.80 mM to 30.00 mM, 2.00 mM to 30.00 mM, 0.90 mM to 20.00 mM, 2.50 mM to 20.00 mM, 1.00 mM to 10.00 mM, 3.00 mM to 10.00 mM, 1.50 mM to 5.00 mM, or 3.50 mM to 5.00 mM.

[0041] The total content of equol and 5-hydroxyequol in cultures(or a fermented material) at the completion of culture (or fermentation) is not particularly limited. The total content may be, for example, 0.01 mM or more, 0.02 mM or more, 0.05

mM or more, 0.10 mM or more, 0.50 mM or more, 1.00 mM or more, 1.50 mM or more, 2.00 mM or more, 2.50 mM or more, 3.00 mM or more, 3.50 mM or more, 4.00 mM or more, 4.50 mM or more, 5.00 mM or more, 5.50 mM or more, 6.00 mM or more, 6.50 mM or more, 7.00 mM or more, 7.50 mM or more, 8.00 mM or more, 8.50 mM or more, 9.00 mM or more, 9.50 mM or more, 10.00 mM or more, 10.50 mM or more, 11.00 mM or more, 11.50 mM or more, 12.00 mM or more, 12.50 mM or more, 13.00 mM or more, 13.50 mM or more, 14.00 mM or more, 14.50 mM or more, 15.00 mM or more, 15.50 mM or more, 16.00 mM or more, 16.50 mM or more, or 17.00 mM or more. The upper limit thereof is not particularly limited and may be, for example, 400.00 mM or less, 300.00 mM or less, 200.00 mM or less, 100.00 mM or less, 50.00 mM or less, 40.00 mM or less, 30.00 mM or less, or 20.00 mM or less. Specifically, the total content may be, for example, 0.01 mM to 400.00 mM, 0.02 mM to 300.00 mM, 0.05 mM to 200.00 mM, 0.10 mM to 100.00 mM, 0.50 mM to 50.00 mM, 1.00 mM to 40.00 mM, 1.50 mM to 30.00 mM, 2.00 mM to 30.00 mM, or 2.50 mM to 20.00 mM.

[0042] The content of equol in cultures(or a fermented material) at the completion of culture (or fermentation) is not particularly limited. The content may be, for example, 0.01 mM or more, 0.02 mM or more, 0.05 mM or more, 0.10 mM or more, 0.50 mM or more, 1.00 mM or more, 1.50 mM or more, 2.00 mM or more, 2.50 mM or more, 3.00 mM or more, 3.50 mM or more, 4.00 mM or more, 4.50 mM or more, 5.00 mM or more, 5.50 mM or more, 6.00 mM or more, 6.50 mM or more, 7.00 mM or more, 7.50 mM or more, 8.00 mM or more, 8.50 mM or more, 9.00 mM or more, 9.50 mM or more, 10.00 mM or more, 10.50 mM or more, 11.00 mM or more, 11.50 mM or more, 12.00 mM or more, 12.50 mM or more, 13.00 mM or more, 13.50 mM or more, 14.00 mM or more, 14.50 mM or more, 15.00 mM or more, 15.50 mM or more, 16.00 mM or more, 16.50 mM or more, or 17.00 mM or more. The upper limit thereof is not particularly limited and may be, for example, 400.00 mM or less, 300.00 mM or less, 200.00 mM or less, 100.00 mM or less, 50.00 mM or less, 40.00

mM or less, 30.00 mM or less, or 20.00 mM or less. Specifically, the content may be, for example, 0.01 mM to 400.00 mM, 0.02 mM to 300.00 mM, 0.05 mM to 200.00 mM, 0.10 mM to 100.00 mM, 0.50 mM to 50.00 mM, 1.00 mM to 40.00 mM, 1.50 mM to 30.00 mM, 2.00 mM to 30.00 mM, or 2.50 mM to 20.00 mM.

[0043] The content of 5-hydroxyequol in cultures(or a fermented material) at the completion of culture (or fermentation) is not particularly limited. The content may be, for example, 0.01 mM or more, 0.02 mM or more, 0.05 mM or more, 0.10 mM or more, 0.50 mM or more, 1.00 mM or more, 1.50 mM or more, 2.00 mM or more, 2.50 mM or more, 3.00 mM or more, 3.50 mM or more, 4.00 mM or more, 4.50 mM or more, 5.00 mM or more, 5.50 mM or more, 6.00 mM or more, 6.50 mM or more, 7.00 mM or more, 7.50 mM or more, 8.00 mM or more, 8.50 mM or more, 9.00 mM or more, 9.50 mM or more, 10.00 mM or more, 10.50 mM or more, 11.00 mM or more, 11.50 mM or more, 12.00 mM or more, 12.50 mM or more, 13.00 mM or more, 13.50 mM or more, 14.00 mM or more, 14.50 mM or more, 15.00 mM or more, 15.50 mM or more, 16.00 mM or more, 16.50 mM or more, or 17.00 mM or more. The upper limit thereof is not particularly limited and may be, for example, 400.00 mM or less, 300.00 mM or less, 200.00 mM or less, 100.00 mM or less, 50.00 mM or less, 40.00 mM or less, 30.00 mM or less, 20.00 mM or less, or 10.00 mM or less. The lower limit and the upper limit may be combined so as not to contradict each other. Specifically, the content may be, for example, 0.01 mM to 400.00 mM, 0.02 mM to 300.00 mM, 0.05 mM to 200.00 mM, 0.10 mM to 100.00 mM, 0.50 mM to 50.00 mM, 1.00 mM to 40.00 mM, 1.50 mM to 30.00 mM, 2.00 mM to 30.00 mM, 2.50 mM to 20.00 mM, or 3.00 mM to 10.00 mM.

[0044] A fermented material containing equol and 5-hydroxyequol at arbitrary values and ratio in terms of a weight per g dry weight is obtained by fermenting daidzeins and genisteins with a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins.

[0045] The values per g dry weight of equol and 5-hydroxyequol in the resulting fermented material are, for example, as follows.

Equol: The value may be 0.1 mg/g or more, 0.2 mg/g or more, 0.3 mg/g or more, 0.4 mg/g or more, 0.5 mg/g or more, 0.6 mg/g or more, 0.7 mg/g or more, 0.8 mg/g or more, 0.9 mg/g or more, 1.0 mg/ g or more, 1.1 mg/g or more, 1.2 mg/g or more, 1.3 mg/g or more, 1.4 mg/g or more, 1.5 mg/g or more, 1.6 mg/g or more, 1.7 mg/g or more, 1.8 mg/g or more, 1.9 mg/g or more, 2.0 mg/g or more, 2.1 mg/g or more, 2.2 mg/g or more, 2.3 mg/g or more, 2.4 mg/g or more, 2.5 mg/g or more, 2.6 mg/g or more, 2.7 mg/g or more, 2.8 mg/g or more, 2.9 mg/g or more, 3.0 mg/g or more, 3.5 mg/g or more, 4.0 mg/g or more, 4.5 mg/g or more, 5.0 mg/g or more, 6.0 mg/g or more, 7.0 mg/g or more, 8.0 mg/g or more, 9.0 mg/g or more, 10.0 mg/g or more, 11.0 mg/g or more, 12.0 mg/g or more, 13.0 mg/g or more, 14.0 mg/g or more, 15.0 mg/g or more, 16.0 mg/g or more, 17.0 mg/g or more, 18.0 mg/g or more, 19.0 mg/g or more, 20.0 mg/g or more, 25.0 mg/g or more, or 30.0 mg/g or more. The upper limit thereof is not particularly limited and may be, for example, 500.0 mg/g or less, 400.0 mg/g or less, 300.0 mg/g or less, 200.0 mg/g or less, 100.0 mg/g or less, or 50.0 mg/g or less. Specifically, the value may be, for example, 0.1 mg/g to 500.0 mg/g, 0.2 mg/g to 400.0 mg/g, 0.3 mg/g to 300.0 mg/g, 0.4 mg/g to 200.0 mg/g, 0.5 mg/g to 100.0 mg/g, or 0.6 mg/g to 50.0 mg/g.

5-Hydroxyequol: The value may be 0.1 mg/g or more, 0.2 mg/g or more, 0.3 mg/g or more, 0.4 mg/g or more, 0.5 mg/g or more, 0.6 mg/g or more, 0.7 mg/g or more, 0.8 mg/g or more, 0.9 mg/g or more, 1.0 mg/g or more, 1.1 mg/g or more, 1.2 mg/g or more, 1.3 mg/g or more, 1.4 mg/g or more, 1.5 mg/g or more, 1.6 mg/g or more, 1.7 mg/g or more, 1.8 mg/g or more, 1.9 mg/g or more, 2.0 mg/g or more, 2.1 mg/g or more, 2.2 mg/g or more, 2.3 mg/g or more, 2.4 mg/g or more, 2.5 mg/g or more, 2.6 mg/g or more, 2.7 mg/g or more, 2.8 mg/g or more, 2.9 mg/g or more, 3.0 mg/g or more, 3.5 mg/g or more, 4.0 mg/g or more, 4.5 mg/g or more, 5.0 mg/g or more, 6.0 mg/g or more, 7.0 mg/g or more, 8.0 mg/g or more, 9.0 mg/g or more, 10.0

mg/g or more, 11.0 mg/g or more, 12.0 mg/g or more, 13.0 mg/g or more, 14.0 mg/g or more, 15.0 mg/g or more, 16.0 mg/g or more, 17.0 mg/g or more, 18.0 mg/g or more, 19.0 mg/g or more, 20.0 mg/g or more, 25.0 mg/g or more, or 30.0 mg/g or more. The upper limit thereof is not particularly limited and may be, for example, 500.0 mg/g or less, 400.0 mg/g or less, 300.0 mg/g or less, 200.0 mg/g or less, 100.0 mg/g or less, or 50.0 mg/g or less. Specifically, the value may be, for example, 0.1 mg/g to 500.0 mg/g, 0.2 mg/g to 400.0 mg/g, 0.3 mg/g to 300.0 mg/g, 0.4 mg/g to 200.0 mg/g, 0.5 mg/g to 100.0 mg/g, or 0.6 mg/g to 50.0 mg/g.

Total content of equol and 5-hydroxyequol: The total content may be 0.1 mg/g or more, 0.2 mg/g or more, 0.3 mg/g or more, 0.4 mg/g or more, 0.5 mg/g or more, 0.6 mg/g or more, 0.7 mg/g or more, 0.8 mg/g or more, 0.9 mg/g or more, 1.0 mg/g or more, 1.1 mg/g or more, 1.2 mg/g or more, 1.3 mg/g or more, 1.4 mg/g or more, 1.5 mg/g or more, 1.6 mg/g or more, 1.7 mg/g or more, 1.8 mg/g or more, 1.9 mg/g or more, 2.0 mg/g or more, 2.1 mg/g or more, 2.2 mg/g or more, 2.3 mg/g or more, 2.4 mg/g or more, 2.5 mg/g or more, 2.6 mg/g or more, 2.7 mg/g or more, 2.8 mg/g or more, 2.9 mg/g or more, 3.0 mg/g or more, 3.5 mg/g or more, 4.0 mg/g or more, 4.5 mg/g or more, 5.0 mg/g or more, 6.0 mg/g or more, 7.0 mg/g or more, 8.0 mg/g or more, 9.0 mg/g or more, 10.0 mg/g or more, 11.0 mg/g or more, 12.0 mg/g or more, 13.0 mg/g or more, 14.0 mg/g or more, 15.0 mg/g or more, 16.0 mg/g or more, 17.0 mg/g or more, 18.0 mg/g or more, 19.0 mg/g or more, 20.0 mg/g or more, 25.0 mg/g or more, or 30.0 mg/g or more. The upper limit thereof is not particularly limited and may be, for example, 500.0 mg/g or less, 400.0 mg/g or less, 300.0 mg/g or less, 200.0 mg/g or less, 100.0 mg/g or less, or 50.0 mg/g or less. Specifically, the total content may be, for example, 0.1 mg/g to 500.0 mg/g, 0.2 mg/g to 400.0 mg/g, 0.3 mg/g to 300.0 mg/g, 0.4 mg/g to 200.0 mg/g, 0.5 mg/g to 100.0 mg/g, or 0.6 mg/g to 50.0 mg/g.

[0046] The value per g dry weight of ornithine in the resulting fermented material is exemplified by 5 mg/g to 30 mg/g, preferably 7 mg/g to 20 mg/g, more preferably 8 mg/g to 15 mg/g.

The value per g dry weight of genisteins in the resulting fermented material is exemplified by 0.02 mg/g to 2.5 mg/g, preferably 0.05 mg/g to 2 mg/g.

The value per g dry weight of glyciteins in the resulting fermented material is exemplified by 0.1 mg/g to 8.5 mg/g, preferably 2.5 mg/g to 6.5 mg/g.

The value per g dry weight of daidzeins in the resulting fermented material is exemplified by 0.1 mg/g to 30 mg/g, preferably 0.1 mg/g to 1.5 mg/g.

[0047] It is preferable that the resulting fermented material should contain substantially no allergen. In this context, examples of the allergen include Gym4, Gm30k, Gm28k, 7S globulin, oleosin, and trypsin inhibitors. The term "contain substantially no" can be the extent that no band is detected by visual determination of test strip using, for example, FASTKIT Slim Soybean (manufactured by Research & Development Center, NH Foods Ltd.) or Allergen Eye(R) Immunochromato (manufactured by Prima Meat Packers, Ltd.), or the like.

[0048] The ratio of the content of 5-hydroxyequol per g dry weight to the content of equol per g dry weight, i.e., a ratio determined by dividing 5-hydroxyequol (mg/g) by equol (mg/g), in the resulting fermented material is, for example, as follows.

The ratio may be 0.001 or more, 0.005 or more, 0.01 or more, 0.02 or more, 0.03 or more, 0.04 or more, 0.05 or more, 0.06 or more, 0.07 or more, 0.08 or more, 0.09 or more, 0.10 or more, 0.20 or more, 0.30 or more, 0.40 or more, 0.50 or more, 0.60 or more, 0.70 or more, 0.80 or more, 0.90 or more, 1.00 or more, 1.50 or more, 2.00 or more, 3.00 or more, 4.00 or more, or 5.00 or more. The upper limit thereof is not particularly limited and may be, for example, 30.00 or less, 20.00 or less, 10.00 or less, 9.00 or less, 8.00 or less, 7.00 or less, 6.00 or less, 5.00 or less, 4.00 or less, 3.00 or less, 2.00 or less, 1.00 or less, or 0.50 or less. Specifically, the ratio may be, for example, 0.001 to 30.00, 0.005 to 20.00, 0.01 to 10.00, 0.02 to 9.00, 0.03 to 8.00,

0.04 to 7.00, 0.05 to 6.00, 0.06 to 5.00, 0.07 to 4.00, 0.08 to 3.00, 0.09 to 2.00, 0.10 to 1.00, or 0.20 to 0.50.

[0049] The ratio of the molar concentration of 5-hydroxyequol to the molar concentration of equol, i.e., a ratio determined by dividing 5-hydroxyequol (mmol/L) by equol (mmol/L), in the resulting fermented material is, for example, as follows.

The ratio may be 0.001 or more, 0.005 or more, 0.010 or more, 0.020 or more, 0.030 or more, 0.04 or more, 0.05 or more, 0.06 or more, 0.07 or more, 0.08 or more, 0.09 or more, 0.10 or more, 0.20 or more, 0.30 or more, 0.40 or more, 0.50 or more, 0.60 or more, 0.70 or more, 0.80 or more, 0.90 or more, 1.00 or more, 1.50 or more, 2.00 or more, 3.00 or more, 4.00 or more, or 5.00 or more. The upper limit thereof is not particularly limited and may be, for example, 30.00 or less, 20.00 or less, 10.00 or less, 9.00 or less, 8.00 or less, 7.00 or less, 6.00 or less, 5.00 or less, 4.00 or less, 3.00 or less, 2.00 or less, 1.00 or less, or 0.50 or less. Specifically, the ratio may be, for example, 0.001 to 30.00, 0.005 to 20.00, 0.01 to 10.00, 0.02 to 9.00, 0.03 to 8.00, 0.04 to 7.00, 0.05 to 6.00, 0.06 to 5.00, 0.07 to 4.00, 0.08 to 3.00, 0.09 to 2.00, 0.10 to 1.00, or 0.20 to 0.50.

[0050] The production method may comprise the step of quantifying the obtained equol and 5-hydroxyequol. The quantification method can be in accordance with a routine method. For example, a portion of a culture liquid is collected, appropriately diluted or dissolved in an organic solvent or subjected to extraction with an organic solvent, stirred well, then filtered using a membrane such as a polytetrafluoroethylene (PTFE) membrane or the like to remove insoluble matter, and the resultant is quantified by high performance liquid chromatography.

[0051] The production method may comprise the step of purifying or enriching equol and 5-hydroxyequol from the obtained composition or fermented material containing equol and 5-hydroxyequol, for example. The purification treatment in the purification step can be performed by treatment including sterilization of microorganisms by heat or the like; eradication of bacteria and removal of polymer

substances by microfiltration (MF), ultrafiltration (UF), or the like; recovery or removal of water-insoluble solids by centrifugal sedimentation or filtration; extraction with an organic solvent, an ionic liquid, or the like; and adsorption and decolorization using a hydrophobic adsorbent, an ion-exchange resin, activated carbon, or a derivatized silica gel as it is or in the state of a column packed therewith, or the like. Examples of the enrichment treatment in the enrichment step include enrichment using various evaporators (in vacuum or under normal pressure, centrifugal film evaporators, falling film evaporators, wiped-film evaporators, and the like), reverse osmosis membranes, ion-exchange membranes, or the like.

[0052] The composition or the fermented material containing equol and 5-hydroxyequol may be directly used or may be formed into a powder by, for example, a batch drying method such as fluidized-bed drying, freeze drying, stirring drying (a Nauta mixer, a conical dryer, or a ribbon mixer dryer), or the like, or a continuous drying method such as fluidized-bed drying, a drum dryer, spray drying, or the like. Before or after this powder formation, the method described in the above paragraph may be performed. For the powder formation, an excipient such as lactose, dextrin, corn starch, or the like may be added. The powder thus dried may be prepared into a powder more suitable for powder processing, if necessary, by grinding using a mortar, a homogenizer, a Waring blender, a jet mill, a bead mill, a ball mill, or the like, or by sieving or sizing. The thus-obtained composition or fermented material containing equol and 5-hydroxyequol, or the composition or the fermented material treated by purification can be used in cosmetics, quasi-drugs, medical products, hygiene products, medicaments, foods and drinks (including supplements), and the like, for example, thereby allowing subjects including humans to conveniently obtain known effects brought about by equol and 5-hydroxyequol through use or ingestion thereof.

[0053] Equol has a preventive effect (anti-estrogen effect) on breast cancer, prostate cancer, and the like as well as an effect (estrogen-like effect) on the prevention and

treatment of irregular menstruation and medically unexplained symptoms or symptoms associated with menopause in middle-aged women, such as "having hot flashes, experiencing excessive sweating, having cold back, hands, and feet, getting short of breath, having numbness in hands and feet, having loss of sensation in hands and feet, having trouble falling asleep at night, waking up easily during the night, getting easily excited, getting nervous, worrying about trivial things, feeling dizzy or nauseous, getting tired easily, having a stiff shoulder, a backache, or joint pain in arms and legs, having a headache, having palpitations, having a sensation of ants crawling on the skin, having rough skin", and the like in menopausal women within 5 years after menopause; osteoporosis after menopause; hyperlipemia; hypertension; and the like.

5-Hydroxyequol has the estrogen-like effect mentioned above and 3-β-hydroxysteroid dehydrogenase inhibitory activity.

In the present disclosure, application thereof may be use for a therapeutic purpose or may be use for a nontherapeutic purpose. Alternatively, use for a preventive purpose is also possible.

The symptoms mentioned above may be classified into "symptoms attributed to diseases" and "symptoms attributed to causes other than diseases". For example, foods and drinks (including supplements) or foods and drinks for specified health use may be intended for "symptoms attributed to causes other than diseases", and healthy individuals may be used as subjects.

The effect on "hyperlipemia or hypertension" or the like may be "useful for keeping lipid or blood pressure at a healthy level" in foods and drinks for specified health use. Other estrogen-like effects may also be "useful for keeping a level equivalent to healthy individuals" in foods and drinks for specified health use.

[0054] For example, use of a composition or a fermented material containing equol and 5-hydroxyequol for producing a functional food composition or a food composition for specified health use which improves medically unexplained

symptoms or symptoms associated with menopause in healthy middle-aged women may be provided. The composition or the fermented material containing equol and 5-hydroxyequol may be obtained by the production method of the present disclosure. The composition or the fermented material containing equol and 5-hydroxyequol may be, for example, a composition or a fermented material containing equol and 5-hydroxyequol, wherein a total content of equol and 5-hydroxyequol in the fermented material is 0.5 mg/g or more and 100.0 mg/g or less per g dry weight, a content of 5-hydroxyequol in the fermented material is 0.3 mg/g or more per g dry weight, the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof. The total content of equol and 5-hydroxyequol in the composition or the fermented material, the content of 5-hydroxyequol and the content of equol in the composition or the fermented material, and the like are not particularly limited, and the numerical values or the numerical ranges of the present disclosure can be used in appropriate combination.

[0055] As mentioned above, a composition containing equol and 5-hydroxyequol, or a fermented material containing equol and 5-hydroxyequol can be obtained by a method for producing equol and 5-hydroxyequol, or a method for producing a fermented material containing equol and 5-hydroxyequol. Hereinafter, the fermented material will be described for the sake of convenience, and the description can also be equally applied to the composition.

[0056] The fermented material containing equol and 5-hydroxyequol (hereinafter, also simply referred to as the fermented material) may contain an acid such as citric acid, succinic acid, fumaric acid, lactic acid, gluconic acid, acetic acid, malic acid, orotic acid, ascorbic acid, benzoic acid, hydrochloric acid, sulfuric acid, phosphoric acid, or the like; or a salt or a chelate of the acid. The salt is not particularly limited and may be an alkali metal salt, an alkaline earth metal salt, or the like. The chelate is not particularly limited.

The content of the acid or the salt or the chelate of the acid in the fermented material may be 0.7 to 20% by weight, 0.8 to 17% by weight, 0.8 to 14% by weight, 0.8 to 11% by weight, or 0.8 to 9% by weight with respect to 100% by weight of the fermented material.

The fermented material may contain alkali metal hydroxide or alkaline earth metal hydroxide such as sodium hydroxide, potassium hydroxide, calcium hydroxide, calcium oxide, magnesium hydroxide, or the like; or alkali metal carbonate or alkaline earth metal carbonate such as sodium carbonate, sodium bicarbonate, calcium carbonate, calcium bicarbonate, or the like.

[0057] When 50 g of a dried fermented material is dissolved or suspended in 1 L of water, pH of the solution or the suspension may be 4 to 9 or 5 to 8.

[0058] The fermented material may contain a substance produced in the course of fermentation, or a substance contained in a raw material, such as 5-hydroxy-dehydroequol, ornithine, or the like.

For example, when the fermented material is desired to contain ornithine, it is preferable to use a microorganism having the ability to produce equol from daidzeins and the ability to produce 5-hydroxyequol from genisteins, and further having the ability to produce ornithine from arginine. It is also preferable to incorporate arginine in a raw material composition containing daidzeins and genisteins. In this case, the content of ornithine can be adjusted depending on the abundance of arginine. The microorganism having the ability to produce equol from daidzeins, the ability to produce 5-hydroxyequol from genisteins, and the ability to produce ornithine from arginine can be obtained by screening the microorganisms mentioned above by a usual method using the ability to produce equol from daidzeins, the ability to produce 5-hydroxyequol from genisteins, and the ability to produce ornithine from arginine as an index.

[0059] The fermented material may be, for example, a fermented material of a composition comprising daidzeins and genisteins, wherein the fermented material

contains equol and 5-hydroxyequol, a total content of equol and 5-hydroxyequol in the fermented material is 0.5 mg/g or more and 100.0 mg/g or less per g dry weight, a content of 5-hydroxyequol in the fermented material is 0.3 mg/g or more per g dry weight, the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof. The total content of equol and 5-hydroxyequol in the fermented material, the content of 5-hydroxyequol and the content of equol in the fermented material, and the like are not particularly limited, and the numerical values or the numerical ranges of the present disclosure can be used in appropriate combination.

[0060] The fermented material can be used, either directly or by containing a base material or other components, to prepare a cosmetic, a quasi-drug, a medical product, a hygiene product, a medicament, a food or drink (including a supplement), or the like.

[0061] Hereinafter, an oral composition, for example, an oral composition for a medicament or an oral composition for a food or drink (including a supplement) or the like will be described, though the oral composition is not limited thereto.

The composition or the fermented material containing equol and 5-hydroxyequol, or equol and 5-hydroxyequol treated by purification can be used in an oral composition. The present disclosure can provide, for example, a method for producing an oral composition.

Specifically, a method for producing an oral composition, comprising the step of incorporating equol and 5-hydroxyequol in a base material, wherein the equol and the 5-hydroxyequol are produced by the production method of the present disclosure. However, the present disclosure is not limited by the method for producing an oral composition and can also be applied to a percutaneous composition and a transfusion composition by appropriately changing the base material or the like.

[0062] The amounts of equol and 5-hydroxyequol contained in the oral composition are not particularly limited as long as the effect of interest is exerted; thus, it is preferable to appropriately select the amounts depending on the form of the composition, the number of times of ingestion, the health condition of a subject, and the like. The amounts can abide by a law or a guideline, if present. For example, the amounts of equol, 5-hydroxyequol, equol and 5-hydroxyequol differ depending on the form of the composition, the number of times of ingestion, a purpose, and the like and can be appropriately selected from a range on the order of, for example, 0.000001% by weight to 20.0% by weight with respect to the total weight of the composition. The amount of a base material or other components given below is not particularly limited as long as each effect of interest is exerted; thus, it is preferable to appropriately select the amount depending on the form of the composition, the number of times of ingestion, the health condition of a subject, and the like. The amount can abide by a law or a guideline, if present.

[0063] In this context, the base material or other components can be exemplified by, but not particularly limited to, the following materials.

Amino acids: for example, BCAA (valine/leucine/isoleucine), alanine, arginine, glutamine, lysine, aspartic acid, glutamic acid, proline, cysteine, threonine, methionine, histidine, phenylalanine, tyrosine, tryptophan, asparagine, glycine, serine, γ-aminobutyric acid (GABA), hydroxyproline, ornithine, and citrulline.

[0064] Crude drugs: For example, ginseng (dried root of *Panax ginseng* C.A. Mey. of the family *Araliaceae*), Huangjing (rhizome of *Polygonatum sibiricum* Red. of the family *Liliaceae*), donkey glue (hide glue produced by concentrating dehaired skin of *Equus asinus* L. of the family *Equidae*), goji berry (dried ripened fruit of *Lycium chinense* Miller of the family Solanaceae), Hampi (product obtained by gutting and skinning *Gloydius blomhoffii* H. Boie or *Gloydius brevicaudus* Stejneger of the family *Viperidae*, and stretching and drying the resultant), Dioscorea rhizome (dried rhizome of *Dioscorea japonica* Thunberg or *Dioscorea batatas* Decaisne of the

family *Dioscoreaceae*), jujube (dried ripened fruit of *Ziziphus jujuba* var. *spinosa* of the family *Rhamnaceae* and plants of the same genus thereas), mulberry fruit (ripened fruit of *Morus alba* Linne of the family *Moraceae*), safflower (dried corolla of *Carthamus tinctorius* Linne of the family *Compositae*), cinnamon bark, turmeric (dried rhizome of *Curcuma longa* L. and *Curcuma aromatica* of the family *Zingiberaceae*), jujube seed (dried ripened seed of *Ziziphus jujuba* Miller var. spinosa Hu ex H. F. Chou of the family *Rhamnaceae*), longan aril (pulp of *Euphoria longana* Lamarck of the family *Sapindaceae*), citrus Unshiu peel (dried peel of *Citrus unshiu* Marcowicz or *Citrus reticulata* Blanco of the family *Rutaceae*), sea horse (product obtained by degutting *Hippocampus kelloggi* and *Hippocampus trimaculatus* of the family Syngnathidae), Chinese caterpillar fungus (fruiting body and sclerotium of *Cordyceps sinensis* (Berk.) Sacc. Of the family *Clavicipitaceae*), fenugreek (seed of *Trigonella foenum-graecum* of the family Legume), and Cornus fruit (dried fruit of *Cornus officinali*s Siebold et Zuccarini of the family *Cornaceae*) can be used. A blend with the crude drug may be used by Kanpo prescription. These crude drugs can be ground, further used in the forms of powders, or subjected to extraction with an alcohol, hot water, or the like so that the extracts are dried and formed into powders, which are in turn used as extracted powders, depending on the forms and dosage forms thereof.

[0065] Vitamins: For example, vitamins B1 such as thiamine hydrochloride, thiamine nitrate, bisthiamine nitrate, dicethiamine hydrochloride, dibenzoyl thiamine, dibenzoyl thiamine hydrochloride, thiamine cetylsulfate, thiamine thiocyanate, thiamine naphthalene-1,5-disulfonate, thiamine lauryl sulfate, and the like; vitamins B2 such as riboflavin, sodium riboflavin phosphate, and the like; vitamins B6 such as pyridoxin hydrochloride, pyridoxal phosphate, and the like; vitamins B12 such as hydroxocobalamin hydrochloride, hydroxocobalamin acetate, cyanocobalamin, hydroxocobalamin, and the like; pantothenic acids such as folic acid, biotin, panthenol, calcium pantothenate, sodium pantothenate, and the like; nicotinic acids

such as nicotinic acid, nicotinamide, and the like; vitamins C such as ascorbic acid, sodium ascorbate, calcium ascorbate, ascorbyl stearate, and the like; vitamins P such as methyl hesperidin, rutin, and the like; powder products of vitamins D such as vitamin D1, vitamin D2, vitamin D3, vitamin D4, and the like; powder products of vitamins K such as vitamin K1, vitamin K2, vitamin K3, vitamin K4, vitamin K5, vitamin K6, vitamin K7, and the like; powder products of carotenoid compounds such as palm oil carotene, dunaliella carotene, cryptoxanthin, zeaxanthin, canthaxanthin, astaxanthin, β-apo-8'-carotenal, bixin, lycopene, and the like; powder products of vitamins E such as d-α-tocopherol, d-β-tocopherol, d-γ-tocopherol, d-σ-tocopherol, tocotrienol, and the like; powder products of vitamins F such as linoleic acid, linolenic acid, arachidonic acid, and the like; and the like.

[0066] Minerals: For example, 12 minerals announced as Recommended Dietary Allowances for Japanese, the 6th revision by the Ministry of Health and Welfare in fiscal 2000 (calcium, magnesium, iron, zinc, selenium, chromium, manganese, copper, molybdenum, potassium, phosphorus, and iodine). Such minerals may be inorganic minerals or may be organic minerals. The organic mineral according to the present invention may be a mineral in which, for example, a metal such as zinc, copper, or the like is chemically bound with an amino acid as a constituent of a protein, or an organic compound.

[0067] Organic minerals: For example, commercially available products of minerals incorporated in yeast cells, such as zinc yeast, magnesium yeast, iron yeast, selenium yeast, chromium yeast, manganese yeast, copper yeast, molybdenum yeast, and iodine yeast, heme iron obtained by enzymatically treating hemoglobin, followed by ultrafiltration or isoelectric precipitation and subsequent drying, and the like. On the other hand, examples of the inorganic mineral include commercially available products of natural calcium and natural magnesium that may be used in foods, such as dolomite, eggshell calcium, coral calcium, sea urchin shell calcium, calcified algae, pearl calcium, bovine bone calcium, fish bone calcium, fish scale calcium,

milk calcium, and the like. For example, dolomite is obtained by coarsely crushing raw dolomite and sterilizing the resultant by heating, followed by grinding, and use of dolomite produces a composition suitable for the absorption of calcium because the blending ratio between calcium and magnesium is 2:1.

[0068] Herbs: For example, milk thistle extracts, turmeric extracts, mulberry leaf extracts, gymnema sylvestre extracts, ginkgo biloba leaf extracts, Siberian ginseng extracts, blueberry extracts, St. John's wort extracts, saw palmetto fruit extracts, pumpkin seed extracts, raspberry leaf extracts, Perilla ocymoides seed extracts, Perilla ocymoides leaf extracts, rooibos tea extracts, Coix seed extracts, echinacea purpurea extracts, melilot extracts, Pueraria mirifica root powders, chaste tree extracts, pomegranate seed extracts, Garcinia cambogia extracts, Citrus aurantium extracts, clove extracts, Centella asiatica extracts, grape seed extracts, red wine extracts, millet extracts, horsetail extracts, Agaricus extracts, Maitake mushroom extracts, garlic extracts, Kidachi aloe extracts, propolis extracts, and the like. These herbs are obtained by separating and concentrating ground fruits, seeds, leaves, or the like, or extracts obtained by extraction from fruits, seeds, leaves, or the like with an aqueous ethanol solution or the like, blending the concentrates, if necessary, with an additive such as an excipient or the like, and drying the blend, and commercially available products can be used.

[0069] Further examples thereof include phytosterol, red yeast rice powders, soybean, soybean hypocotyl, fermented soybean, fermented soybean hypocotyl, red clover, kudzu (*Pueraria lobata*), soybean extracts, soybean hypocotyl extracts, fermented soybean extracts, fermented soybean hypocotyl extracts, red clover extracts, kudzu (*Pueraria lobata*) extracts, glucosamine, chondroitin sulfate-containing mucopolysaccharide protein, collagen peptide, chitosan, silk peptide, inositol, protein, *Bifidobacterium* powders, lactic acid bacterium powders, beer yeast, chlorella, spirulina, royal jelly powders, green tea polyphenol, red wine polyphenol, apple polyphenol, grape seed polyphenol, grape leaf polyphenol, oolong tea

polyphenol, perilla polyphenol, buckwheat polyphenol, cacao polyphenol, coffee polyphenol, sweat tea polyphenol, perilla extracts, cacao extracts, buckwheat extracts, citrus peel extracts, blueberry extracts, green tea extracts, coffee extracts, apple extracts, evening primrose extracts, oolong tea extracts, grape seed extracts, grape leaf extracts, eucalyptus extracts, guava extracts, sweet tea extracts, litchee seed extracts, cranberry extracts, banana juice, apple juice, grape juice, strawberry juice, melon juice, apple juice, mango juice, muscat juice, white grape juice, lemon juice, lime juice, mandarin juice, grapefruit juice, yuzu juice, and the like, and commercially available products can be used.

[0070] Further examples thereof can include wheat flour, soft flour, butter, egg, dextrin, wheat starch, rice starch, corn starch, potato starch, pregelatinized starch, partly pregelatinized starch, kinako (roasted soybean flour), glutinous rice flour, matcha (powdered green tea), black sesame, gluten, honey, skimmed milk powder, baking powder, maltose, reduced lactose, reduced maltose, sorbitol, mannitol, erythritol, xylitol, saccharose, glucose, brown sugar, guar gum, xanthan gum, sodium alginate, gum arabic, tragacanth gum, pullulan, agar, gelatin, soybean dietary fiber, methylcellulose, ethylcellulose, hydroxypropylcellulose, hydroxypropylmethylcellulose, hydroxypropylmethylcellulose phthalate, hydroxypropylmethylcellulose acetate succinate, carboxymethylethylcellulose, cellulose acetate phthalate, hydroxyethylcellulose, hydroxypropyl starch, polyvinylpyrrolidone, low substituted hydroxypropylcellulose, carmellose, carmellose calcium, carmellose sodium, croscarmellose sodium, sodium carboxymethyl starch, hydrogenated plant oils, plant fat/oil powders, carnauba wax, cocoa butter powder, sucrose fatty acid ester, stearic acid, magnesium stearate, aluminum stearate, calcium stearate, silicon dioxide, talc, aluminum silicate, calcium hydrogen phosphate, common salt, potassium chloride, calcium lactate, acesulfame K, aspartame, advantame, neotame, licorice extracts, stevia, stevia extracts, sucralose, thaumatin, Luohanguo extracts, and the like.

[0071] Further examples thereof can include gallic acid, derivatives of the acid (e.g., gallic acid methyl, ethyl, propyl, or butyl ester), alkali metal (sodium, potassium, or the like) salts of gallic acid, chlorogenic acid, ellagic acid, tannic acid, tannin (e.g., proanthocyanidin, gallotannin, and ellagitannin), flavonoids (e.g., flavone, flavonol, flavanone, flavanonol, isoflavone, anthocyanin, flavanol (catechin, epicatechin, gallocatechin, epigallocatechin, epicatechin gallate, epigallocatechin gallate, and the like)), chalcone, aurone, and the like.

[0072] When the oral composition is a food or drink composition, the composition may contain an acid without impairing flavor. Examples of the acid include, but are not particularly limited to, acids such as citric acid, succinic acid, fumaric acid, lactic acid, gluconic acid, acetic acid, malic acid, orotic acid, ascorbic acid, benzoic acid, hydrochloric acid, sulfuric acid, phosphoric acid, and the like; and salts and chelates of these acids. The salt is not particularly limited and may be an alkali metal salt, an alkaline earth metal salt, or the like. The chelate is not particularly limited.

The composition may contain alkali metal hydroxide or alkaline earth metal hydroxide such as sodium hydroxide, potassium hydroxide, calcium hydroxide, calcium oxide, magnesium hydroxide, or the like; or alkali metal carbonate or alkaline earth metal carbonate such as sodium carbonate, sodium bicarbonate, calcium carbonate, calcium bicarbonate, or the like.

The content of the acid or the salt or the chelate of the acid in the food or drink composition may be 0.5 to 14% by weight, 0.6 to 12% by weight, 0.7 to 10% by weight, 0.8 to 8% by weight, or 0.8 to 6% by weight with respect to 100% by weight of the food or drink composition.

[0073] For example, the pH of the food or drink composition may usually be 4 to 9 or 5 to 8. The pH can be directly measured if the composition is liquid. The composition in a non-liquid state is preferably prepared into a dried material, 50 g of which is dissolved or suspended in 1 L of water for measurement.

The pH of the food or drink composition may be adjusted with a pH adjuster, and examples of the pH adjuster include, but are not particularly limited to, acids such as citric acid, succinic acid, fumaric acid, lactic acid, gluconic acid, acetic acid, malic acid, orotic acid, ascorbic acid, benzoic acid, hydrochloric acid, sulfuric acid, phosphoric acid, and the like; salts and chelates of these acids; alkali metal hydroxide or alkaline earth metal hydroxide such as sodium hydroxide, potassium hydroxide, calcium hydroxide, calcium oxide, magnesium hydroxide, and the like; alkali metal carbonate or alkaline earth metal carbonate such as sodium carbonate, sodium bicarbonate, calcium carbonate, calcium bicarbonate, and the like; and the like. The salts of these acids are not particularly limited and may each be an alkali metal salt, an alkaline earth metal salt, or the like. The chelates of these acids are not particularly limited.

[0074] Specific examples of the food or drink composition will be shown, though the food or drink composition is not limited thereto:

soft beverages, carbonated beverages, fruit juice beverages, vegetable beverages, tea beverages, coffee beverages, milk beverages, soymilk beverages, fermented beverages, yogurt, cocoa beverages, sport beverages, nutritional supplement beverages, energy bars, low-calorie beverages, alcoholic beverages, nonalcoholic taste beverages, jelly beverages, frozen beverages, smoothies, herbal tea, candies, starch syrups, ices, tablet candies, supplements, creamy foods, seasonings, retort foods, processed meat products, paste foods, processed egg foods, canned products or canned foods, frozen desserts, processed soybean foods, nutritional supplement foods, confectionery (cookies, biscuits, chocolates, chips, cake, chewing gums, candies, gummies, steamed bun stuffed with sweet bean paste, sweet bean jelly, puddings, jelly, yogurt, ice cream, sherbets, nut bars, fruit snacks, macarons, and the like), bread, noodles, rice dishes, cereal foods, soups (powdered or freeze-dried), miso soups (powdered or freeze-dried), and the like. In the case of a beverage composition, a known base material can be used without particular

limitations, and it is preferred to arbitrarily use, for example, a flavor, a fragrance, and an acidulant (citric anhydride or the like) as well as a stabilizer (pectin, soybean polysaccharides, or the like), a thickener (tamarind gum or the like), an emulsifier (sucrose fatty acid ester or the like), milk (cow milk, skimmed milk powder, or the like), a pH adjuster, and the like.

[0075] The amounts of equol and 5-hydroxyequol contained in the food or drink composition are not particularly limited as long as the effect of interest is exerted; thus, it is preferable to appropriately select the amounts depending on the form of the composition, the number of times of ingestion, the health condition of a subject, and the like. The amounts can abide by a law or a guideline, if present. For example, the amounts of equol, 5-hydroxyequol, equol and 5-hydroxyequol differ depending on the form of the composition, the number of times of ingestion, a purpose, and the like and can be appropriately selected from a range on the order of, for example, 0.000001% by weight to 20.0% by weight with respect to the total weight of the composition. The amount of a base material or other components given below is not particularly limited as long as each effect of interest is exerted; thus, it is preferable to appropriately select the amount depending on the form of the composition, the number of times of ingestion, the health condition of a subject, and the like. The amount can abide by a law or a guideline, if present.

[0076] For example, when the food or drink composition is a jelly beverage, specifically, a method for producing a composition for a jelly beverage, comprising the step of incorporating equol and 5-hydroxyequol in a base material, wherein the equol and the 5-hydroxyequol are produced by the production method of the present disclosure, can be provided.

For example, a component selected from gelling agents such as konjac powder, carrageenan, gelatin, pectin, agar, alginic acid, locust bean gum, xanthan gum, and the like, and other components, and the like depending on a purpose is preferably used as the base material. For example, a jelly beverage composition

containing collagen peptide, agar, and equol and 5-hydroxyequol may contain approximately 0.02% by weight to 25% by weight of collagen peptide and have an equol content on the order of 0.005 to 2.0% by weight, or may contain approximately 2% by weight to 3% by weight of collagen peptide and have an equol content on the order of 0.01 to 0.05% by weight, with respect to the total weight of the jelly beverage composition. In the case of a jelly beverage, the pH may be 2.5 to 4.0. The pH may be adjusted with a pH adjuster, and the pH adjuster in this case may be used, for adjustment, in combination with an organic acid such as phytic acid, citric acid, gluconic acid, succinic acid, acetic acid, tartaric acid, lactic acid, fumaric acid, malic acid, or the like, an inorganic acid such as hydrochloric acid, phosphoric acid, or the like, or fruit juice that exhibits acidity, such as lemon juice, apple juice, or the like.

[0077] For example, when the food or drink composition is sparkling water, specifically, a method for producing a composition for sparkling water, comprising the step of incorporating equol and 5-hydroxyequol in a base material, wherein the equol and the 5-hydroxyequol are produced by the production method of the present disclosure, can be provided.

For example, a component selected from liquids such as water, carbonated water, and the like, various flavors, a pH adjuster, other components, and the like depending on a purpose is preferably used as the base material.

[0078] As mentioned above, the oral composition may contain the fermented material of the present disclosure. Specifically, the oral composition comprises a fermented material containing equol and 5-hydroxyequol, and a base material. In this case, the blending proportion of the fermented material is not particularly limited and is appropriately set depending on the equol content of the oral composition and the form of the oral composition. As one example, the proportion of the fermented material (dried material) contained in the oral composition is exemplified by a

proportion of 1 to 90% by weight, preferably 20 to 85% by weight, preferably 30 to 80% by weight.

[0079] The oral composition containing the fermented material may be a food or drink composition containing the fermented material. When the food or drink composition is a jelly beverage, specifically, the food or drink composition may be a jelly beverage composition containing collagen peptide, agar, and a fermented material containing equol and 5-hydroxyequol. In this case, the jelly beverage composition may contain approximately 0.02% by weight to 25% by weight of collagen peptide and have an equol content on the order of 0.005 to 2.0% by weight, or may contain approximately 2% by weight to 3% by weight of collagen peptide and have an equol content on the order of 0.01 to 0.05% by weight, with respect to the total weight of the jelly beverage.

[0080] For example, the concentration of equol in the food or drink composition containing the fermented material is 0.005 to 10.0% by weight, preferably 0.1 to 7.0% by weight, more preferably 0.3 to 3.0% by weight. For example, the concentration of 5-hydroxyequol in the food or drink composition containing the fermented material is 0.005 to 10.0% by weight, preferably 0.1 to 7.0% by weight, more preferably 0.3 to 3.0% by weight. For example, the concentration of ornithine in the food or drink composition containing the fermented material is 0.008 to 30.0% by weight, preferably 0.15 to 20% by weight. For example, the concentration of daidzeins in the food or drink composition containing the fermented material is 0.001 to 2.0% by weight, preferably 0.2 to 0.6% by weight. For example, the concentration of genisteins in the food or drink composition containing the fermented material is 0.001 to 2.0% by weight, preferably 0.1 to 0.6% by weight. For example, the concentration of glyciteins in the food or drink composition containing the fermented material is 0.001 to 2.0% by weight, preferably 0.2 to 0.6% by weight.

[0081] Hereinafter, the case in which the oral composition is a solid preparation will be described, though the oral composition is not limited thereto. The solid

preparation is not particularly limited by its form or shape and includes a solid preparation in an arbitrary form or shape known to those skilled in the art, for example, tablets, granules, films, sheets, and the like.

[0082] The oral composition can additionally contain, if necessary, optional pharmaceutically or food hygienically acceptable components such as an excipient, a co-excipient, a disintegrant, a surfactant, a lubricant, an acidulant, a sweetener, a corrigent, a flavor, a colorant, a stabilizer, a fluidizer, a binder, and the like, in addition to equol and 5-hydroxyequol. For example, the corresponding components described in Japanese Pharmaceutical Excipients Directory (Yakuji Nippo, Ltd.) or the Japanese Pharmacopoeia and designated additives based on Food Sanitation Act, Article 10 or existing additives, natural flavors, or additives listed in general food additive lists can be used as these optional components. The types of the optional components are not particularly limited. The blending proportion thereof in the oral composition is not particularly limited and can be appropriately determined by those skilled in the art, as long as the desired effects of the present disclosure are exerted.

Examples of the excipient include arbitrary sugar alcohols and sugars known to those skilled in the art. Representative examples of the sugar alcohol or the sugar can include mannitol, erythritol, xylitol, trehalose, lactose, maltose, maltitol, glucose, sucrose, fructose, mannose, sorbitol, and the like. Preferable examples thereof can include mannitol, erythritol, xylitol, trehalose, and lactose. Although one type of sugar of sugar alcohol may be used, two or more types of compounds appropriately selected from thereamong may be used.

For example, starch or an inorganic excipient can be used as the disintegrant and the co-excipient. Examples of the starch can include corn starch, potato starch, waxy corn starch, partly pregelatinized starch, pregelatinized starch, and the like. Examples of the inorganic excipient can include light anhydrous silicic acid, hydrated silicon dioxide, anhydrous calcium phosphate, anhydrous calcium hydrogen

phosphate, aluminum metasilicate, calcium silicate, magnesium silicate, magnesium oxide, and the like.

[0083] The oral composition of the present disclosure can be produced by an arbitrary method or approach known to those skilled in the art.

For example, the oral composition of the present disclosure can be produced by mixing various components contained in the oral composition at once.

Alternatively, the oral composition can also be produced by various granulation processes. The granulation approach is not particularly limited, and the oral composition may be produced by a dry granulation method, a wet granulation process, or the like.

The dry granulation method comprises the step of mixing various component powders contained in the oral composition either directly or with an appropriate binder or the like, preparing small masses under strong pressure, and appropriately crushing the masses, followed by granulation. Specific examples of the dry granulation method can include a crushing granulation method, a roll compression method, and the like.

The wet granulation method is a method of dispersing the components in the presence of water and drying the dispersion to form a complex, and specific examples of the wet granulation method can include spraying methods such as spray drying, tumbling granulation, stirring granulation, fluidized-bed granulation, and the like, a freeze drying method, kneading granulation, and the like, among which an arbitrary method known to those skilled in the art can be used for production.

In the case of production by the wet granulation process, the oral composition of the present disclosure may be produced by a single granulation step of using together all the components contained in the oral composition, or the components may be added and mixed in a plurality of wet granulation steps.

Whether any one or two types of components among the components contained in the oral composition are used in the plurality of wet granulation steps in

the production method described above can be appropriately determined by those skilled in the art, depending on the types and amounts thereof, and the like.

In each granulation step, conditions such as a spray rate, an air feeding temperature, an exhaust temperature, an amount of air feed, and the like can be appropriately determined by those skilled in the art, depending on the type and amount of each component, and the like.

For all the granulation steps, examples of the vehicle of a spray liquid can include solvents acceptable for medicaments or foods, such as water, ethanol, methanol, acetone, and the like. Alternatively, examples of the spray liquid include aqueous solutions containing less than 10% of the components of the oral composition dissolved therein, and the like, with water or such an aqueous solution particularly preferable. Various arbitrary components described above which may be appropriately contained in the oral composition of the present disclosure can be appropriately added in each granulation step. Alternatively, another wet granulation step may be separately established, and these arbitrary components can be added and mixed at this stage.

[0084] All the prior art literatures cited herein are incorporated herein by reference.

Examples

[0085] Hereinafter, the present disclosure will be described further specifically with reference to Examples, though the present disclosure is not limited by these Examples.

[0086] In each Example, isoflavones were quantified by the following method.

[0087] (Quantification of concentrations of isoflavones)

To 2 g of a culture liquid, a 70% aqueous ethanol solution is added to adjust the volume to 50 mL, and after ultrasonic solubilization, a filtrate obtained by filtration through a 0.45 μm filter is analyzed by HPLC.

[0088] (Method for calculating concentrations of isoflavones)

The concentration of daidzin is determined from a single-point calibration curve using daidzin (manufactured by FUJIFILM Wako Pure Chemical Corp., product No. 046-2 7743) as a standard. The respective concentrations of other isoflavones are calculated using quantitative coefficients for daidzin described in WO2017/170995, i.e., malonyldaidzin (1.444), malonylglycitin (1.351), malonylgenistin (1.095), acetyldaidzin (1.094), acetylglycitin (1.197), and acetylgenistin (1.064), and quantitative coefficients obtained by Daicel Corp., i.e., glycitin (1.199), genistin (0.840), daidzin (0.665), glycitein (0.789), dihydrodaidzein (3.432), and dihydrogenistein (8.364).

As for the calculation of the concentrations of isoflavone aglycones and metabolites, the concentrations are determined from single-point calibration curves using daidzein (manufactured by LC Laboratories, Inc., product No. D-2946), glycitein (manufactured by FUJIFILM Wako Pure Chemical Corp., product No. 076-04703), genistein (manufactured by FUJIFILM Wako Pure Chemical Corp., product No. 073-05531), dihydrodaidzein (manufactured by Toronto Research Chemicals, Inc., product No. D449 000), dihydrogenistein (synthetic product of Nagara Science Co., Ltd.), equol (manufactured by Daicel Corp., product No. 100152-00lG), and 5-hydroxyequol (manufactured by Toronto Research Chemicals, Inc., product No. H825750) as standards.

[0089] (HPLC analysis of isoflavones)

The following method is used on the basis of Notification of the Ministry of Health, Labour and Welfare (Shoku-An-Hatsu No. 0823001).

Column: YMC-Pack ODS-AM

with an inside diameter of 4.6 mm and a length of 250 mm (YMC Co., Ltd.)

Column temperature: 25°C

Mobile phase: (Solution A) acetonitrile/water/acetic acid = 15/85/0.1 (v/v/v)

(Solution B) acetonitrile/water/acetic acid = 35/65/0.1 (v/v/v)

Gradient conditions: Solution A Solution B

0 min	100	0
50 min	0	100
55 min	0	100
56 min	100	0
65 min	100	0

Flow rate: 1.0 mL/min

Detector: Ultraviolet spectrophotometer (254 nm)

Injection volume: 10 μL

Equipment used: HPLC (manufactured by Shimadzu Corp.)

[0090] (Preculture)

The preculture medium used was ABB medium (anaerobe basal broth; manufactured by Thermo Fisher Scientific, Inc.), and each strain shown in Table 2 was inoculated thereto, and after the gas phase was purged with hydrogen gas through a sterile filter, culture medium was shake-cultured at 200 spm at 37°C for 24 hours to obtain a preculture liquid. The SI strain was treated in the same manner as above except that Wilkins-Chalgren (abbreviation: WC) medium was used.

[0091] (Main culture)

(Examples 1 to 3)

To 100 g/L soybean hypocotyl (containing isoflavone glycosides such as daidzin, glycitin, genistin, and the like), 0.2 g/L Pectinase G Amano (manufactured by Amano Enzyme Inc.) was added, and the mixture was held overnight at 50°C with stirring so that sugars were liberated from the isoflavone glycosides to give aglycones.

Yeast extracts (containing arginine) as a nutrient and β-cyclodextrin (β-CD) as an additive were added thereto, and pH at the start of main culture was adjusted to 6.50 to 7.10 to prepare a medium formulation at the start of main culture shown in Table 1.

[0092] (Comparative Examples 1 to 3 and Examples 4 to 12)

Daidzein, genistein, ABB medium as a nutrient, arginine, and optionally β-CD as an additive were added thereto, and pH at the start of main culture was adjusted to 6.50 to 7.10 to prepare a medium formulation at the start of main culture shown in Table 1.

[0093] (Example 13)

To 100 g/L soybean hypocotyl (containing isoflavone glycosides such as daidzin, glycitin, genistin, and the like), 0.2 g/L Pectinase G Amano (manufactured by Amano Enzyme Inc.) was added, and the mixture was held overnight at 50°C with stirring so that sugars were liberated from the isoflavone glycosides to give aglycones. Arginine as a nutrient was added thereto, and pH at the start of main culture was adjusted to 6.50 to 7.10 to prepare a medium formulation at the start of main culture shown in Table 1.

[0094] Each of the main culture media of Examples 1 to 13 and Comparative Examples 1 to 3 thus prepared was dispensed at 15 mL/vial to 100 mL vials, which were then sealed with butyl rubber stoppers, purged with nitrogen gas, and then sterilized in an autoclave at 121°C for 15 minutes. The preculture liquid was inoculated to the main culture medium (inoculation rate: 1%), and after the gas phase was purged with hydrogen gas through a sterile filter, culture medium was shake-cultured at 250 rpm at 37°C for the culture time described in Table 1. After culture, isoflavones were analyzed.

[0095] (Examples 14 and 15)

Daidzein, genistein, ABB medium yeast extracts as a nutrient, arginine, and optionally β-CD as an additive were added thereto, and pH at the start of main culture was adjusted to 6.50 to 7.10 to prepare a medium formulation at the start of main culture shown in Table 1.

Each of the main culture media of Examples 14 and 15 thus prepared was dispensed at 1 L/jar to 2 L mini jars, which were then purged with nitrogen gas and then sterilized in an autoclave at 121°C for 15 minutes.

The preculture liquid was inoculated to the main culture medium (inoculation rate: 1%), and cultured with stirring at 500 rpm at 37°C for the culture time described in Table 1 during aeration with anaerobic gas through a sterile filter.

After culture, isoflavones were analyzed.

The results are shown in Table 1. Table 2 shows the details of the strains used and their abbreviations.

[0096] [Table 1]

Table 1

Example Comparative Example	Strain	Medium formulation at start of main culture			Culture time	Amount of 5HEQ produced	Amount of EQ produced	Genisteins /daidzeins molar concentration ratio	5HEQ molar conversion rate	5HEQ molar conversion efficiency	EQ molar conversion rate	EQ molar conversion efficiency
		Isoflavones	Nutrient	Additive	(h)	(mM)	(mM)		(%)	(%/h)	(%)	(%/h)
Example 1	AC	Soybean hypocotyl extract Daidzein 13.67 mM Genistein 0.94 mM	Yeast extract Arginine Corresponding to 0.75 g/L	β-CD 16.5 g/L	44	0.67	11.88	0.069	71.3%	1.620	86.3%	1.961
Example 2	AC	Soybean hypocotyl extract Daidzein 14.75 mM Genistein 1.42 mM	Yeast extract Arginine Corresponding to 0.75 g/L	β-CD 16.5 g/L	44	0.78	12.45	0.096	55.0%	1.250	84.4%	1.918
Example 3	AC	Soybean hypocotyl extract Daidzein 14.49 mM Genistein 1.79 mM	Yeast extract Arginine Corresponding to 0.75 g/L	β-CD 16.5 g/L	44	1.06	11.93	0.124	59.2%	1.345	82.3%	1.872
Comparative Example 1	AC	Daidzein 13.79 mM Genistein 9.81 mM	ABB medium Arginine Corresponding to 1 g/L		46	0.35		0.711	3.6%	0.077		
Comparative Example 2	AE	Daidzein 13.70 mM Genistein 9.89 mM	ABB medium Arginine Corresponding to 1 g/L		46	0.50		0.721	5.1%	0.111		
Comparative Example 3	SI	Daidzein 196.77 μM Genistein 185.02 μM	WC medium Arginine Corresponding to 1 g/L		72	14.8 μM	76.7 μM	0.940	8.0%	0.111	39.0%	0.541
Example 4	AE	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L		46	0.70	0.59	1.882	18.9%	0.412	30.2%	0.657
Example 5	AC	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L		46	0.45	0.61	1.882	12.1%	0.264	30.9%	0.671
Example 6	SE	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L		46	0.59	0.54	1.882	15.9%	0.346	27.3%	0.593
Example 7	AC	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L	Arginine 2 g/L	46	1.05	0.63	1.882	28.4%	0.616	32.1%	0.698
Example 8	AE	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L	Arginine 2 g/L	46	1.15	0.56	1.882	31.0%	0.673	28.3%	0.616
Example 9	AC	Daidzein 0.787 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L	β-CD 16.5 g/L	46	3.33	0.70	4.704	90.0%	1.956	89.2%	1.939
Example 10	AC	Daidzein 1.573 mM Genistein 7.401 mM	ABB medium Arginine Corresponding to 1 g/L	β-CD 16.5 g/L	46	5.65	1.28	4.704	76.4%	1.661	81.3%	1.768
Example 11	AE	Daidzein 0.787 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L	β-CD 16.5 g/L	46	3.49	0.74	4.704	94.2%	2.047	94.4%	2.053
Example 12	AE	Daidzein 1.573 mM Genistein 7.401 mM	ABB medium Arginine Corresponding to 1 g/L	β-CD 16.5 g/L	46	6.00	1.28	4.704	81.1%	1.763	81.3%	1.768
Example 13	SE	Soybean hypocotyl Daidzein 2.44 mM Genistein 0.671 mM	Arginine 1 g/L		96	0.47	2.11	0.275	69.3%	0.722	86.5%	0.901
Example 14	SE	Daidzein 3.93 mM Genistein 1.85 mM	ABB medium Arginine Corresponding to 1 g/L		46	0.41	0.54	0.470	21.9%	0.476	13.7%	0.298
Example 15	AC	Daidzein 3.93 mM Genistein 1.85 mM	ABB medium Arginine Corresponding to 1 g/L		46	0.41	0.71	0.470	22.3%	0.485	18.0%	0.391

[0097] [Table 2]

Table 2

Abbreviation	Details of strain
AE	Adlercreutzia equolifaciens subsp. equolifaciens DSM 19450 strain
AC	Adlercreutzia equolifaciens subsp. celatus DSM 18785 strain
SI	Slackia isoflavoniconvertens DSM 22006 strain
SE	Slackia equolifaciens DSM 24851 strain

[0098] By use of these techniques, a fermented material containing equol and 5-hydroxyequol at arbitrary values and ratio, as illustrated in Table 3, in terms of a weight per g dry weight can be produced by fermenting daidzeins and genisteins with a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins.

As for enzymes involved in equol production, since equol is known to inhibit the activity of daidzein reductase (DZNR) (Applied and Environmental Microbiology, 2016, Vol. 82, No. 7, 1992-2002), 5-hydroxyequol is also presumed to have similar inhibition. Hence, it is predicted that the conversion of genisteins to 5-hydroxyequol is easily inhibited in the presence of daidzeins and genisteins near equimolar concentrations, although the reason for this is not certain. The conversion of genisteins to 5-hydroxyequol is presumably facilitated in an environment as the concentrations daidzeins and genisteins diverge from the equimolar concentrations.

[0099] [Table 3]

Table 3

Example Comparative Example	Strain	Medium formulation at start of main culture			Culture time	Amount A of 5HEQ produced	Amount B of EQ produced	A/B
		Isoflavones	Nutrient	Additive	(h)	(mg/g)	(mg/g)	
Example 4	AE	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L		46	4.9	3.9	1.26
Example 5	AC	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L		46	3.1	4.0	0.79
Example 6	SE	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L		46	4.1	3.5	1.17
Example 7	AC	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L	Arginine 2 g/L	46	7.0	3.9	1.77
Example 8	AE	Daidzein 1.966 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L	Arginine 2 g/L	46	7.6	3.5	2.19
Example 9	AC	Daidzein 0.787 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L	β-CD 16.5 g/L	46	20.4	4.0	5.06
Example 10	AC	Daidzein 1.573 mM Genistein 7.401 mM	ABB medium Arginine Corresponding to 1 g/L	β-CD 16.5 g/L	46	32.5	6.9	4.71
Example 11	AE	Daidzein 0.787 mM Genistein 3.700 mM	ABB medium Arginine Corresponding to 1 g/L	β-CD 16.5 g/L	46	21.4	4.3	5.00
Example 12	AE	Daidzein 1.573 mM Genistein 7.401 mM	ABB medium Arginine Corresponding to 1 g/L	β-CD 16.5 g/L	46	34.5	6.9	5.00
Example 13	SE	Soybean hypocotyl Daidzein 2.44 mM Genistein 0.671 mM	Arginine 1 g/L		96	1.2	5.0	0.20
Example 14	SE	Daidzein 3.93 mM Genistein 1.85 mM	ABB medium Arginine Corresponding to 1 g/L		46	2.8	3.5	0.80
Example 15	AC	Daidzein 3.93 mM Genistein 1.85 mM	ABB medium Arginine Corresponding to 1 g/L		46	2.9	4.6	0.60

Industrial Applicability

[0100] The present disclosure enables efficient production of equol and 5-hydroxyequol, and the obtained equol and 5-hydroxyequol can be used in cosmetics,

quasi-drugs, medical products, hygiene products, medicaments, foods and drinks (including supplements), and the like, for example, thereby allowing subjects including humans to conveniently obtain known effects brought about by equol and 5-hydroxyequol through use or ingestion thereof.

CLAIMS

[Claim 1]

A method for producing equol and 5-hydroxyequol using a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins, wherein

the daidzeins and the genisteins are present at the start of culture of the microorganism,

molar conversion efficiency from the genisteins to 5-hydroxyequol is 0.150%/h or more,

a molar concentration ratio of the genisteins to the daidzeins at the start of the culture is 1.300 or more or 0.700 or less,

the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and

the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof.

[Claim 2]

A method for producing a fermented material containing equol and 5-hydroxyequol

by culturing a microorganism having the ability to produce equol from daidzeins, and the ability to produce 5-hydroxyequol from genisteins, wherein

the daidzeins and the genisteins are present at the start of culture of the microorganism,

a molar concentration ratio of the genisteins to the daidzeins at the start of the culture is 1.300 or more or 0.700 or less,

a total content of equol and 5-hydroxyequol in the fermented material is 0.5 mg/g or more and 100.0 mg/g or less per g dry weight,

the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and

the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof.

[Claim 3]

A method for producing an oral composition, comprising the step of incorporating

equol and 5-hydroxyequol,

in a base material, wherein

the equol and the 5-hydroxyequol are produced by the method according to claim 1 or 2.

[Claim 4]

A method for producing a composition for a jelly beverage, comprising the step of incorporating

equol,

5-hydroxyequol,

collagen peptide, and

agar, wherein

the equol and the 5-hydroxyequol are produced by the method according to claim 1 or 2.

[Claim 5]

The method for producing a composition for a jelly beverage according to claim 4, wherein

the equol is 0.01% by weight to 0.05% by weight

with respect to the total weight of the composition.

[Claim 6]

A fermented material of a composition comprising daidzeins and genisteins, wherein

the fermented material contains equol and 5-hydroxyequol,

a total content of equol and 5-hydroxyequol in the fermented material is 0.5 mg/g or more and 100.0 mg/g or less per g dry weight,

a content of 5-hydroxyequol in the fermented material is 0.3 mg/g or more per g dry weight,

the daidzeins are daidzin, malonyldaidzin, acetyldaidzin, daidzein, dihydrodaidzein, or a combination thereof, and

the genisteins are genistin, malonylgenistin, acetylgenistin, genistein, dihydrogenistein, or a combination thereof.

[Claim 7]

An oral composition comprising the fermented material according to claim 6 and a base material.

[Claim 8]

A composition for a jelly beverage, comprising

the fermented material according to claim 6,

collagen peptide, and

agar.

[Claim 9]

The composition for a jelly beverage according to claim 8, wherein

the equol is 0.01% by weight to 0.05% by weight

with respect to the total weight of the composition.