

DESCRIPTION

GREEN TEA BEVERAGE HAVING ENHANCED FLAVOR

TECHNICAL FIELD

[0001] The present invention relates to a technique of enhancing the taste of a green tea beverage. More particularly, this invention relates to a technique of enhancing a profound and rich taste like *Gyokuro* tea in a green tea beverage.

BACKGROUND ART

[0002] As consumer preferences are diversified, there has been a demand for a tea beverage having a differentiated or high-valued aroma. In particular, consumers demand not only green tea beverages intended for hydration (*i.e.*, thirst-quenching) purposes, which taste clean and are easy to drink so that people can gulp quickly in large quantities, but also highly palatable green tea beverages which give a sense of fulfillment (also called “robustness”) after drinking, such as those green tea beverages having strong bitterness and astringency or having a rich *umami* taste. Therefore, many highly palatable green tea leaves characterized by their sweet taste, *umami* taste, etc. have been distributed and commercialized in the market.

[0003] In recent years, packaged green tea beverages which are readily drinkable have been prevailing in the market. Some green tea materials, like high-grade *Gyokuro*, are strong in *umami* taste. However, from the viewpoints of production volume and price, it is difficult to use such high-grade tea leaves for industrial purposes as a source material for packaged green tea beverages. Also, even when such high-grade tea leaves are used, the deterioration of taste is unavoidable due to various factors, such as generation of heat deterioration odor caused by a treatment (*e.g.*, heat sterilization) that is unique to the production of packaged green tea beverages, and the influence on aroma caused by addition of an alkaline component (*e.g.*, sodium bicarbonate) for the purpose of enhancing storage stability. Thus, there have been many reports on techniques of enhancing the taste of a packaged green tea beverage. Examples of such reported techniques include: a technique of

imparting a sense of robustness to a green tea beverage by adding trace amounts of (Z)-3-hexen-1-ol or indol (PTL 1); a technique of enhancing a body sensation and aroma by adding, to a liquid tea extract, a tea extract adjusted such that the percentages of dry solid matter content, total lipid content, phospholipid content, and ethanol concentration can fall within particular ranges (PTL 2); a technique of imparting and enhancing *umami* and *kokumi* tastes using a particular fraction of a tea extract with water and/or a water-soluble organic solvent (PTL 3); and a technique of enhancing tastes, such as a deep taste and a body sensation, by increasing the tea leaf sensation of a tea beverage using a heat-treated liquid green tea extract (PTL 4).

[0004] PTL 5 discloses that when 2-mercapto-3-methyl-1-butanol is added to a sugar-containing black tea beverage, there can be obtained a black tea beverage which has strong flavor characteristics such as fullness, body sensation, tea leaf sensation and a sense of fermentation, and gives one a strong sense of richness. Further, PTL 6 discloses that when malic acid and tartaric acid are added to a tea beverage, there can be obtained a novel tea beverage having enhanced tea flavor, and more specifically discloses that combined use of malic acid and tartaric acid produces a harsh taste, enhancing the black tea sensation of a tea beverage, and that when these components are added to a sugar-containing black tea beverage, there can be obtained a black tea beverage that is strong in black tea sensation and astringent taste.

CITATION LIST

PATENT LITERATURES

- [0005] PTL 1: Japanese Unexamined Patent Application Publication No. JP 2008-148605
PTL 2: Japanese Unexamined Patent Application Publication No. JP 2019-140930
PTL 3: Japanese Unexamined Patent Application Publication No. JP 2005-137286
PTL 4: Japanese Unexamined Patent Application Publication No. JP 2013-252111
PTL 5: Japanese Unexamined Patent Application Publication No. JP 2018-201348
PTL 6: Japanese Unexamined Patent Application Publication No. JP 2015-159796

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0006] An object of the present invention is to provide a method for enhancing the taste of a green tea beverage. Another object of this invention is to provide a green tea beverage (particularly, a packaged green tea beverage) having an enhanced taste.

SOLUTION TO PROBLEM

[0007] The present inventors have made intensive studies to achieve the aforementioned object, and as a result, found that the taste of a green tea beverage can be enhanced by adding trace amounts of malic acid and fagomine to the green tea beverage. Thus, the inventors have completed the present invention.

[0008] The present invention includes, but is not limited to, the following embodiments.

[1] A method for enhancing the taste of a green tea beverage, the method comprising incorporating in the green tea beverage from 2.7 to 13 mg of malic acid and from 0.01 to 0.8 mg of fagomine per 100 mL of the beverage.

[2] A green tea beverage having incorporated therein from 2.7 to 13 mg of malic acid and from 0.01 to 0.8 mg of fagomine per 100 mL of the beverage.

[3] A method for producing a green tea beverage, the method comprising a step of adding to the green tea beverage from 2.7 to 13 mg of malic acid and from 0.01 to 0.8 mg of fagomine per 100 mL of the beverage.

ADVANTAGEOUS EFFECTS OF INVENTION

[0009] According to the present invention, a green tea beverage having an enhanced taste can be provided by a simple approach which is to add trace amounts of malic acid and fagomine.

DESCRIPTION OF EMBODIMENTS

[0010] Green tea beverage

The present invention is directed to a green tea beverage. As referred to herein, the “green tea beverage” refers to a beverage prepared by adding a green tea leaf extract, and more specifically, is a generic name for beverages containing a green tea leaf extract obtained from tea leaves -- *i.e.*, tea leaves that are selected from plants of the genus *Camellia* (*e.g.*, the

species *Camellia sinensis*, such as *C. sinensis* var. *sinensis* (including the variety *Yabukita*), *C. sinensis* var. *assamica*) and hybrids thereof, and which are classified as non-fermented tea leaves (e.g., *Sencha* (brewed green tea), *Bancha* (coarse green tea), *Tencha* (non-ground tea leaves used for *Matcha*), *Kamairi-cha* (pot-roasted green teas), *Kukicha* (twig tea), *Bocha* (roasted twig tea), *Mecha* (bud tea)) -- using water, hot water, or an aqueous solution containing an extraction aid. Extraction can be carried out by employing a known method, such as kneader extraction, stirring extraction (batch extraction), countercurrent extraction (drip extraction) or column extraction. Extraction conditions are not particularly limited and can be selected as appropriate depending on the extraction method.

[0011] One preferred embodiment of the green tea beverage of the present invention is a beverage comprising a green tea extract as a primary component. As referred to above, the “beverage comprising a green tea extract as a primary component” refers to a beverage in which the designation of green tea, such as “green tea”, “green tea extract” or the like, is listed high on a list of ingredients labeled in accordance with the Food Labeling Act of Japan (effective on April 2015). Said beverage is preferably a beverage in which the designation of green tea is listed first or second on a list of ingredients, more preferably a beverage in which the designation of green tea is listed first on a list of ingredients.

[0012] A roasted tea beverage, which is prepared with roasted tea leaves obtained by roasting the aforementioned tea leaves classified as non-fermented tea leaves over high heat, has a unique roasted aroma, and a clean smooth taste on the palate because of low contents of catechins and amino acids. In contrast, the green tea beverage of the present invention is a green tea beverage characterized by having a profound and rich taste like *Gyokuro* imparted thereto. However, there is little need to impart a profound and rich taste to a roasted tea beverage, since a roasted tea beverage is characterized by its clean taste. Thus, in a preferred embodiment, the tea beverage of this invention is not a roasted tea beverage. Examples of roasted tea beverages include, but are not limited to, a liquid consisting solely of an extract from roasted tea leaves, a liquid prepared by mixing an extract from roasted tea leaves as a principle component with an extract from unroasted green tea leaves, or a liquid

prepared by adding an additive(s) to such a liquid as mentioned above. As referred to above, the “extract from roasted tea leaves as a principle component” means that the concentration of solids derived from the roasted tea extract is not less than 80% by mass, preferably not less than 90% by mass, based on the solids concentration of the whole extract.

[0013] The green tea beverage of the present invention is a green tea beverage characterized by having an enhanced rich taste (deep taste) like *Gyokuro*. In general, the taste is broadly classified into five categories: sweet, sour, bitter, salty and *umami* tastes. It is known that the taste of a green tea beverage is largely affected by *umami* and bitter tastes. As referred to in this invention, the “enhanced taste” refers to enhancement of the deep taste (also called “body”) of a green tea beverage, which is the sum of *umami* and bitter tastes. The “green tea beverage having an enhanced taste” refers to a green tea beverage having unique *umami* and bitter tastes like *Gyokuro* tea -- i.e., a green tea beverage having “a profound and rich taste”. By using the taste enhancement method of this invention, the deep taste of a green tea beverage which is made, for example, even using low-grade tea leaves can be enhanced to make the green tea beverage taste close to a profound and rich taste like *Gyokuro* tea.

[0014] Malic acid

One of the essential active ingredients used in the taste enhancement method of the present invention is malic acid. Malic acid, also called 2-hydroxybutanedioic acid), is one of organic compounds classified as hydroxy acids (CAS Registry No. 6915-15-7), and is frequently used as an acidulant for foods and beverages because of its refreshing sour taste.

[0015] In the method for enhancing the taste of a green tea beverage of the present invention, malic acid is added as a taste enhancer to a green tea beverage. The origin of malic acid is not particularly limited as long as it is commonly used in the food and beverage field -- for example, both chemically synthesized and naturally occurring malic acid products can be used. Naturally occurring malic acid products can be in any form, including purified product, crude purified product, or extracted essence. Examples of plants containing malic acid include: fruits such as apple, grape, pear, banana, cherry, guava, strawberry and pomegranate; vegetables such as tomato and Japanese apricot; and different types of tea

leaves. Among naturally occurring malic acid products, tea leaf extracts are preferably used from the viewpoint of their aroma. Examples of tea leaves containing malic acid include green tea leaves and mulberry leaves. A mulberry leaf extract is more preferably used since this extract is high in the content of malic acid among different organic acids, and the sour taste of this extract has little impact on the taste of a green tea beverage.

[0016] In the taste enhancement method of the present invention, malic acid is incorporated in a green tea beverage in an amount of from 2.7 to 13 mg per 100 mL of the beverage. It is known that a green tea infusion (also called a liquid green tea extract) with a moderately high malic acid content tastes sweet, and that the threshold malic acid content of a green tea infusion is 400 mg/L (= 40 mg/100 mL) (*Tea Research Journal*, No.93, 2002, p.26-33). In this invention, by using malic acid in a small amount but in combination with fagomine as described later, enhancement of the taste of a green tea beverage can be achieved. When the malic acid content in the green tea beverage is less than 2.7 mg per 100 mL of the beverage, the taste enhancement effect is too weak. On the other hand, when the malic acid content in the green tea beverage is more than 13 mg/100 mL, it is more likely that the sour taste of malic acid may cause the green tea beverage to be perceived as having a peculiar aroma. The lower limit of the malic acid content in the green tea beverage is preferably not less than 2.8 mg, more preferably not less than 3 mg, per 100 mL of the beverage. The upper limit of the malic acid content in the green tea beverage is preferably not more than 12 mg, more preferably not more than 10 mg, per 100 mL of the beverage. The malic acid content in the green tea beverage can be measured using high-performance liquid chromatography (HPLC).

[0017] Fagomine

In the taste enhancement method of the present invention, fagomine is also added as another active ingredient, in addition to malic acid as described above as an essential active ingredient. Fagomine is an alkaloid isolated from buckwheat (*Fagopyrum esculentum*) and other species, and also referred to as “1,2,5-trideoxy-1,5-epimino-D-xylo-hexitol” (CAS Registry No. 53185-12-9). The origin of fagomine as used in this invention is not particularly limited as long as it is commonly used in the food and beverage field -- for

example, both chemically synthesized and naturally occurring fagomine products can be used. Naturally occurring fagomine products can be in any form, including purified product, crude purified product, or extracted essence.

[0018] In the taste enhancement method of the present invention, fagomine is incorporated in a green tea beverage in an amount of from 0.01 to 0.8 mg per 100 mL of the beverage. Combined use of malic acid and fagomine can achieve a higher taste enhancement effect than that of using each of them alone. The lower limit of the fagomine content in the green tea beverage is preferably not less than 0.02 mg, more preferably not less than 0.03 mg, per 100 mL of the beverage. Since the aroma of fagomine may affect the aroma of a green tea beverage, the upper limit of the fagomine content in the green tea beverage is preferably not more than 0.6 mg, more preferably not more than 0.5 mg, per 100 mL of the beverage. The fagomine content in the green tea beverage can be measured using liquid chromatography/tandem mass spectrometry (LC-MS/MS).

[0019] In the present invention, by adding malic acid and fagomine to a green tea beverage, the deep taste of the green tea beverage, which is the sum of *umami* and bitter tastes, can be effectively enhanced. From the viewpoint that the taste enhancement effect of this invention can be exhibited significantly, it is preferred that the green tea beverage should contain specified amounts of an *umami* taste component and a bitter taste component. In particular, when *umami* and bitter taste components derived from green tea leaves are contained in a green tea beverage, the complex taste typical of green tea is enhanced in the green tea beverage. The ratio of malic acid content to fagomine content is not particularly limited -- for example, the weight ratio of malic acid/fagomine may be in the range of from 5 to 210, or from 10 to 100.

[0020] Examples of *umami* taste components derived from green tea leaves include theanine, which is an amino acid component. Examples of bitter taste components derived from green tea leaves include caffeine and catechins. While catechins are generally known as astringent taste components, they are classified herein as one of bitter taste components that form the deep taste of a green tea beverage. Theanine, caffeine and catechins are

commonly found in a green tea leaf extract, but may be additionally added to a green tea beverage depending on the desired effect.

[0021] In the case of adding theanine, any of L-theanine, D-theanine, and DL-theanine can be used. In particular, among them, L-theanine is preferably used, because it is accepted for use as a food additive in foods and the like, and is easily available from the viewpoint of cost. Also, theanine can be in any form, including purified product, crude purified product, or extracted essence. For example, a green tea essence can be used. Examples of commercially available theanine products include Suntheanine® produced by Taiyo Kagaku Co., Ltd. In the case of adding theanine, the amount of theanine added can be determined based on the theanine content in the beverage.

[0022] The theanine content in the green tea beverage is preferably in the range of from 0.2 to 15 mg per 100 mL of the green tea beverage. From the viewpoint that the effect of the present invention can be exhibited significantly, it is preferred that the lower limit of the theanine content should be not less than 0.5 mg, more preferably not less than 1 mg per 100 mL of the green tea beverage. In the case of adding theanine to a packaged green tea beverage prepared through heat sterilization, when the theanine content is more than 15 mg per 100 mL of the green tea beverage, a heat deterioration odor is more likely to occur, interfering with the effect of the present invention. The upper limit of the theanine content is preferably not more than 13 mg, more preferably not more than 10 mg, per 100 mL of the green tea beverage. The theanine content in the beverage can be measured using an automatic amino acid analysis method.

[0023] The form of caffeine is not particularly limited as long as it is of a quality that can be used in beverages. Caffeine can be in any form that can be used as a food additive, including purified product, crude purified product, or extracted essence (green tea essence). The amount of caffeine added can be determined based on the caffeine content in the beverage. From the viewpoint that the effect of the present invention can be exhibited significantly, it is preferred that the lower limit of the caffeine content should be not less than 0.1 mg, more preferably not less than 0.5 mg, still more preferably not less than 1 mg, per

100 mL of the green tea beverage. The upper limit of the caffeine content is preferably not more than 30 mg, more preferably not more than 25 mg, still more preferably not more than 20 mg, per 100 mL of the green tea beverage. The caffeine content in the beverage can be measured using HPLC.

[0024] In a preferred embodiment, the green tea beverage of the present invention comprises a catechin, or more specifically comprises a gallated catechin and/or a non-gallated catechin. It is only necessary that the green tea beverage of this invention should comprise at least one of eight types of catechins. As referred to herein, the “catechin(s)” is a generic term that encompasses non-gallated catechins such as catechin, gallocatechin, epicatechin and epigallocatechin, and gallated catechins such as catechin gallate, gallocatechin gallate, epicatechin gallate and epigallocatechin gallate. When a catechin is added to a green tea beverage, the form of the catechin is not particularly limited as long as it is a quality that can be used in beverages. The catechin can be in any form that can be used as a food additive, including purified product, crude purified product, or extracted essence (green tea essence). In the case of adding a catechin, the amount of the catechin added can be determined based on the catechin content in the beverage. In this invention, the lower limit of the catechin content is preferably not less than 5 mg, more preferably not less than 7 mg, still more preferably not less than 10 mg, per 100 mL of the green tea beverage. The upper limit of the catechin content is preferably not more than 60 mg, more preferably not more than 55 mg, still more preferably not more than 49 mg, per 100 mL of the green tea beverage. The catechin content in the beverage can be measured using HPLC.

[0025] As described above, a green tea beverage comprising specified amounts of malic acid and fagomine, theanine as an *umami* taste component, and caffeine and a catechin as bitter taste components is one of preferred embodiments of the green tea beverage of the present invention having an enhanced taste. To be specific, the green tea beverage of this invention is a green tea beverage comprising from 2.7 to 13 mg of malic acid, from 0.01 to 0.8 mg of fagomine, from 0.2 to 15 mg of theanine, from 0.1 to 30 mg of caffeine, and from 5

to 60 mg of a catechin, per 100 mL of the beverage.

[0026] In addition to the aforementioned components, the green tea beverage of the present invention may have various additives optionally added thereto, to the extent that there is no deviation from the intended object of this invention. Examples of various additives include antioxidant, pigment, emulsifier, preservative, vitamin, essence, and flavoring. Such additives can be used alone or in combination.

[0027] Further, the green tea beverage of the present invention has a pH of preferably from 5.0 to 7.0, more preferably from 5.5 to 6.5. When the beverage has an acidic pH, particularly a pH of less than 5, the sour taste renders the beverage relatively weak in the taste typical of green tea, so that the taste enhancement effect of this invention become less perceivable. The pH of the beverage can be adjusted, as appropriate, using a pH adjustor such as sodium hydrogen carbonate or sodium hydroxide. The pH of the beverage can be measured at 20°C using a commercially available pH meter.

[0028] The green tea beverage of the present invention may be in the form of a packaged green tea beverage. In general, the taste of a green tea beverage is less perceivable when the beverage is drunk at ambient or lower temperatures as compared to when drunk hot. However, since the green tea beverage of this invention having malic acid and fagomine added thereto has an enhanced taste, the taste of the green tea beverage can be perceived pronouncedly even when the green tea beverage packed in a package is drunk in ambient or lower temperature regions. Further, the taste of a packaged green tea beverage is deteriorated by a unique treatment (*e.g.*, heat sterilization or pH adjustment with an alkaline salt) during its production. However, since the green tea beverage of this invention has an enhanced taste, the green tea beverage is advantageous in that even when the beverage is produced in a packaged form, the taste of the beverage can be perceived pronouncedly. Thus, from the viewpoint that the effect of this invention can be exhibited significantly, a packaged green tea beverage is one of preferred embodiments of this invention.

[0029] The package used for the packaged green tea beverage of the present invention can be any of known packages used for common beverages. For example, a resin package, a

metal package, a paper package, a glass package, or the like can be advantageously used. In one embodiment, the packaged green tea beverage can be provided in a form packed and sealed in, for example, a molded package mainly made of polyethylene terephthalate (so-called PET bottle), a metal can, a paper package combined with a metallic foil or plastic film, or a glass bottle. The volume of the green tea beverage of this invention is not particularly limited, and is for example in the range of from 100 mL to 3000 mL, preferably from 350 mL to 2000 mL, more preferably from 500 to 1000 mL.

EXAMPLES

[0030] Hereunder, the present invention will be specifically described in detail by way of experimental examples, but this invention is not limited to these examples. Unless otherwise stated herein, all numerical ranges are inclusive of their endpoints.

[0031] Quantification of different components

(1) Malic acid

A sample solution was appropriately diluted with distilled water for HPLC (produced by FUJIFILM Wako Pure Chemical Corporation). 2 mL of the dilution was filtered by centrifugation using a centrifugal filter (Ultrafree-CL GV, pore size: 0.22 μ m, produced by Merck), and the obtained filtrate was used as an analysis sample.

Quantification was carried out by the absolute calibration curve method or the internal standard method using the areas of peaks detected in a chromatogram reconstituted for the MS range set based on the LC/MS analysis results. The instruments and conditions employed are detailed below.

- HPLC system: 1290 Infinity II (produced by Agilent Technologies)
- Column: ACQUITY UPLC HSS PFP 1.8 μ m, 2.1 $\times$ 150 mm (produced by Waters), two connected in series
- Column temperature: 40°C
- Mobile phase: (A) aqueous solution of 0.1% formic acid (for LC/MS, produced by Thermo Fisher Scientific), (B) acetonitrile (for LC/MS, produced by FUJIFILM Wako Pure Chemical Corporation)

- Mobile phase gradient conditions: 0% B (0-4 min.) → 35% B (14.5 min.) → 95% B (17.5-19.5 min.), waiting time for equilibration: 3.5 min.
- Flow rate: 0.3 mL/min.
- Injection volume: 2 µL
- Post-column treatment: After column elution, acetonitrile (for LC/MS, produced by FUJIFILM Wako Pure Chemical Corporation) was pumped at a rate of 0.1 mL/min. and introduced into a mass spectrometer.
- Mass spectrometer: Q Exactive Focus LC-MS/MS system (produced by Thermo Fisher Scientific)
- Ionization mode: HESI (heated electrospray ionization)
- Ionization unit conditions: Sheath gas flow rate: 50, aux gasflow rate: 10, sweep gas flow rate: 0, spray voltage pos: 3.50/neg 2.50[kV], capillary temp: 200°C, S-Lens RF level: 50.0, aux gas heater temp: 300°C
- Mass spectroscopy unit conditions: Scan measurement on the Orbitrap, duration time: 18.0 min., polarity switching, resolution: 35000, AGC target: 3e6, scan range: m/z 70 to 850
- Divert valve: Waste line (0-1 min.), MS line (1-17.99 min.)
- The quantifier ion used was: m/z 133.01425 (negative) for malic acid. The retention time was determined by analyzing the reference standard. The MS range was set to 5 to 10 ppm. If there is a difference in mass, the m/z value of the aforementioned quantifier ion can be shifted as appropriate.

If no good peak shape or sensitivity is obtained using the aforementioned ion, the AGC target may be changed or the SIM mode may be used.

[0032] (2) Fagomine

Analysis of fagomine in green tea beverage samples was performed using liquid chromatography/tandem mass spectrometry (LC-MS/MS). Green tea beverage samples were vacuum concentrated, if necessary, before analysis.

LC-MS/MS measurement conditions

- Column: TSKgel Amide-80, ϕ 4.6 mm × 250 mm, particle size 5 µm

- Mobile phase: Mixed solution of water, acetonitrile and acetic acid
- Flow rate: 1.0 mL/min.
- Column temperature: 40°C
- Ionization method: Electrospray ionization (positive ion detection mode)
- Mass-to-charge ratio (m/z): 147.9 → 85.9

[0033] (3) Theanine

Theanine was measured using an automatic amino acid analysis method.

- Analyzer: JCL-500/V2 (produced by JEOL Ltd.)
- Column: LCR-6, $\phi 4 \text{ mm} \times 120 \text{ mm}$ (produced by JEOL Ltd.)
- Mobile phase: Lithium citrate buffer (P-12 to P-15, P-21) (produced by JEOL Ltd.)
- Reactant solution: Ninhydrin Coloring Solution Kit II for JEOL (produced by FUJIFILM Wako Pure Chemical Corporation)
- Flow rate: mobile phase: 0.50 mL/min., reactant solution: 0.30 mL/min.
- Measurement wavelength: 570 nm

[0034] (4) Catechins

A green tea beverage was filtered by a filter (0.45 μm) and quantified using reference standards (standard samples) by HPLC (high-performance liquid chromatography). Quantification of catechins was carried out using reference standards of catechin, epicatechin, gallocatechin, epigallocatechin, catechin gallate, epicatechin gallate, gallocatechin gallate, and epigallocatechin gallate (Kurita high-purity reagents).

[0035] (HPLC analysis conditions)

- HPLC system: Tosoh HPLC system LC8020 model II
- Column: TSKgel ODS80T sQA (4.6 mm $\times$ 150 mm)
- Column temperature: 40°C
- Mobile phase A: Water/acetonitrile/trifluoroacetic acid (90:10:0.05)
- Mobile phase B: Water/acetonitrile/trifluoroacetic acid (20:80:0.05)
- Detection: UV 275 nm
- Injection volume: 20 μL

- Flow rate: 1 mL/min.

- Gradient program:

Time (min.)	%A	%B
0	100	0
5	92	8
11	90	10
21	90	10
22	0	100
29	0	100
30	100	0

[0036] Experiment 1: Production and evaluation of green tea beverages (reference example)

Different green tea beverages containing malic acid in different amounts as indicated in Table 1 were produced by adding malic acid (produced by Iwaki & Co., Ltd., purity: 99%) to a green tea beverage (Sample 1-1) obtained from a tea leaf material mainly composed of lightly fired *Sencha* tea leaves. The different green tea beverages produced in this experiment contained 5 mg of theanine, 10 mg of caffeine, and 33 mg of catechins per 100 mL of the beverage. The green tea beverages were adjusted to about pH 6 with addition of sodium hydrogen carbonate.

[0037] The produced green tea beverages were subjected to sensory evaluation for deep taste (profound and rich taste) by five professional panelists. With Sample 1-1 being used as a control, the ratings given by each professional panelist based on the following criteria were discussed again in a free-form manner among all the panelists, and the final ratings were assigned as integer values in consensus among them. The deep taste of green tea beverages, which is perceived as the sum of *umami* and bitter tastes, was rated mainly from the viewpoint of “a profound and rich taste” like the taste of *Gyokuro* tea.

- 4 points: An enhanced deep taste is strongly perceived.

- 3 points: An enhanced deep taste is perceived.

- 2 points: An enhanced deep taste is slightly perceived.

- 1 point: No enhanced deep taste is perceived (the deep taste is comparable to that perceived in Sample 1-1).

[0038] The sensory evaluation results are shown in Table 1. It was confirmed that when malic acid was added to green tea beverages, the beverages became stronger in favorable deep taste and tasted profound and rich -- *i.e.*, the taste of the green tea beverages was enhanced. Additionally, with regard to Sample 1-15, which had a malic acid content of 15 mg/100 mL, enhancement of taste was observed, but the fruit-like sour taste of malic acid was strongly perceived so that the palatability of the green tea beverage was decreased. Also, although the deep taste ratings for Samples 1-13 and 1-14 were the same, some panelists reported that the sour taste of malic acid was slightly perceived in Sample 1-14.

[0039] [Table 1]

Sample	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8
Malic acid content (mg/100 mL)	2.1	2.5	2.7	2.85	3	3.5	4	4.5
Sensory rating (deep taste)	1	2	3	3	3	3	3	3

Sample	1-9	1-10	1-11	1-12	1-13	1-14	1-15
Malic acid content (mg/100 mL)	5	5.5	6	6.5	8	13	15
Sensory rating (deep taste)	3	3	3	3	3	3	3

[0040] Experiment 2: Production and evaluation of green tea beverages

Different green tea beverages containing malic acid and fagomine in different amounts as indicated in the table given below were produced by adding fagomine (produced by Funakoshi Co., Ltd., purity: 98%) to Sample 1-3 with a malic acid content of 2.7 mg/100 mL as used in Experiment 1.

[0041] The results of the sensory evaluation conducted by the same procedure as in Experiment 1 are shown in Table 2. When fagomine was added to green tea beverages, a good bitter aftertaste was imparted to the green tea beverages, so that the deep taste of the green tea beverages was enhanced more strongly than in the case of addition of malic acid alone. Additionally, with regard to Sample 2-6, which had a fagomine content of 1 mg/100 mL, enhancement of taste was observed, but the harsh taste of fagomine was perceived so that the palatability of the green tea beverage was decreased. Also, although the ratings for Samples 2-4 and 2-5 were the same, some panelists reported that the harsh taste of fagomine was slightly perceived in Sample 2-5.

[0042] [Table 2]

Sample	1-3	2-1	2-2	2-3	2-4	2-5	2-6
Fagomine content (mg/100 mL)	0	0.01	0.1	0.2	0.3	0.8	1
Malic acid content (mg/100 mL)	2.7	2.7	2.7	2.7	2.7	2.7	2.7
Sensory rating (deep taste)	3	4	4	4	4	4	4

[0043] Experiment 3: Production and evaluation of green tea beverages (reference example)

Different green tea beverages containing malic acid in different amounts as indicated in the table given below were produced by adding malic acid (produced by Iwaki & Co., Ltd., purity: 99%) to a green tea beverage (Sample 3-1) obtained mainly using heavily fired *Sencha* tea leaves. The different green tea beverages produced in this experiment contained 1.1 mg of theanine, 18 mg of caffeine, and 46 mg of catechins per 100 mL of the beverage. The green tea beverages were adjusted to about pH 6 with addition of sodium hydrogen carbonate.

[0044] The produced green tea beverages were subjected to sensory evaluation by following the same procedure as in Experiment 1, with Sample 3-1 being used as a control.

[0045] The sensory evaluation results are shown in Table 3. Like in Experiment 1, when malic acid was added to green tea beverages, the beverages became stronger in favorable deep taste and tasted profound and rich -- *i.e.*, the taste of the green tea beverages was enhanced. Additionally, with regard to Sample 3-9, which had a malic acid content of 15 mg/100 mL, enhancement of taste was observed, but the fruit-like sour taste of malic acid was perceived so that the palatability of the green tea beverage was decreased.

[0046] [Table 3]

Sample	3-1	3-2	3-3	3-4	3-5	3-6	3-7	3-8	3-9
Malic acid content (mg/100 mL)	1.8	2.5	2.7	3	5	7	10	13	15
Sensory rating (deep taste)	1	2	3	3	3	3	3	3	3

[0047] Experiment 4: Production and evaluation of green tea beverages (reference example)

Different green tea beverages containing malic acid in different amounts as indicated in Table 4 were produced by adding malic acid (produced by Iwaki & Co., Ltd., purity: 99%) to a green tea beverage (Sample 4-1) obtained using *Gyokuro* tea leaves as a source material. The different green tea beverages produced in this experiment contained 13.2 mg of theanine, 18 mg of caffeine, and 34 mg of catechins per 100 mL of the beverage. The green tea beverages were adjusted to about pH 6 with addition of sodium hydrogen carbonate.

[0048] The produced green tea beverages were subjected to sensory evaluation by following the same procedure as in Experiment 1, with Sample 4-1 being used as a control. The sensory evaluation results are shown in Table 4. When malic acid was added to green tea beverages, the taste of the green tea beverages was enhanced.

[0049] [Table 4]

Sample	4-1	4-2	4-3	4-4
Malic acid content (mg/100 mL)	2	2.85	4	13
Sensory rating (deep taste)	1	3	3	3

[0050] Experiment 5: Production and evaluation of green tea beverages

Different green tea beverages (Samples 5-1, 5-2) containing malic acid and fagomine were produced by adding 0.01 mg/100 mL of fagomine (produced by Funakoshi Co., Ltd., purity: 98%) to each of Sample 3-8 as produced in Experiment 3 and Sample 4-4 as produced in Experiment 4.

[0051] The produced green tea beverages were subjected to sensory evaluation. With those green tea beverages produced with no addition of malic acid or fagomine being used as controls, those samples perceived as having a similar deep taste to the control were rated as “±”, those perceived as having an enhanced deep taste were rated as “+”, and those perceived as having a significantly enhanced deep taste were rated as “++”. The ratings given by five professional panelists were discussed again in a free-form manner among all the panelists, and the final ratings were assigned in consensus among them.

[0052] As evident from the results shown in the table given below, it was demonstrated that the deep taste of green tea beverages was significantly enhanced by adding malic acid and fagomine in combination.

[0053] [Table 5]

Sample	3-1	3-8	5-1	4-1	4-4	5-2
Malic acid content (mg/100 mL)	1.8	13	13	2	13	13
Fagomine content (mg/100 mL)	0	0	0.01	0	0	0.01
Sensory rating (deep taste)	Control	+	++	Control	+	++

CLAIMS

1. A method for enhancing the taste of a green tea beverage, the method comprising incorporating in the green tea beverage from 2.7 to 13 mg of malic acid and from 0.01 to 0.8 mg of fagomine per 100 mL of the beverage.
2. A green tea beverage having incorporated therein from 2.7 to 13 mg of malic acid and from 0.01 to 0.8 mg of fagomine per 100 mL of the beverage.
3. A method for producing a green tea beverage, the method comprising a step of adding to the green tea beverage from 2.7 to 13 mg of malic acid and from 0.01 to 0.8 mg of fagomine per 100 mL of the beverage.