8.1 Thaumatin + plant fibers **
(Rank 2)

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Thaumatin + plant fibers (1/2)

Solution

The solution to the problem is invented by Unavoo Food Tech LTD

Patent Published in 2016

Application in food & beverages.

Unavoo Food Technologies

- **The reference discloses about a flavor modifying composition comprising a blend of: Water soluble filler comprising plant fibers and at least one sucrose substitute of natural source**, wherein said flavor modifying composition comprises at least 90% w/w of the filler, the amount being determined when said composition is in dry form, said flavor modifying composition is water soluble.
- The flavor modifying composition wherein the other **sucrose substitute is Thaumatin**.
- The flavor modifying composition wherein the **plant fibers comprise one or more of Acacia fiber and Actilight fiber**.
- **Temperature stability- denoting no sensed change in score of at least flavor intensity after exposure of the product to a temperature above room temperature, at times, up to 50°C, at times up to 100°C, or even up to 150°C; pH stability- denoting no sensed change in score of at least flavor intensity or physical deterioration of a product comprising the composition (e.g. color change, phase separation etc.) after exposure of the product to any pH from 3 to 8, at times, at a pH of between 4 to 8**

Tests

Sensory Test:

- **Flavor modifying composition is dissolved in 180ml water at room temperature to obtain dissolved composition and the taste of the dissolved composition is compared by at least one individual to a reference taste score of a same amount of the at least one sucrose substitute of natural source dissolved in 180ml water at room temperature in the absence of said filler.**

Results

- **It was observed that the composition was successful in masking the unpleasant aftertaste.**

Application

- The method is applicable for producing a sweetening composition with masking effect of unpleasant aftertaste.

Conventional Solutions

The conventional sweeteners have an issues of causing unpleasant aftertaste/mouthfeel.

Advantages

The Sweetener produced by this method is capable or preventing the occurrence of unpleasant aftertaste or mouthfeel.

Source

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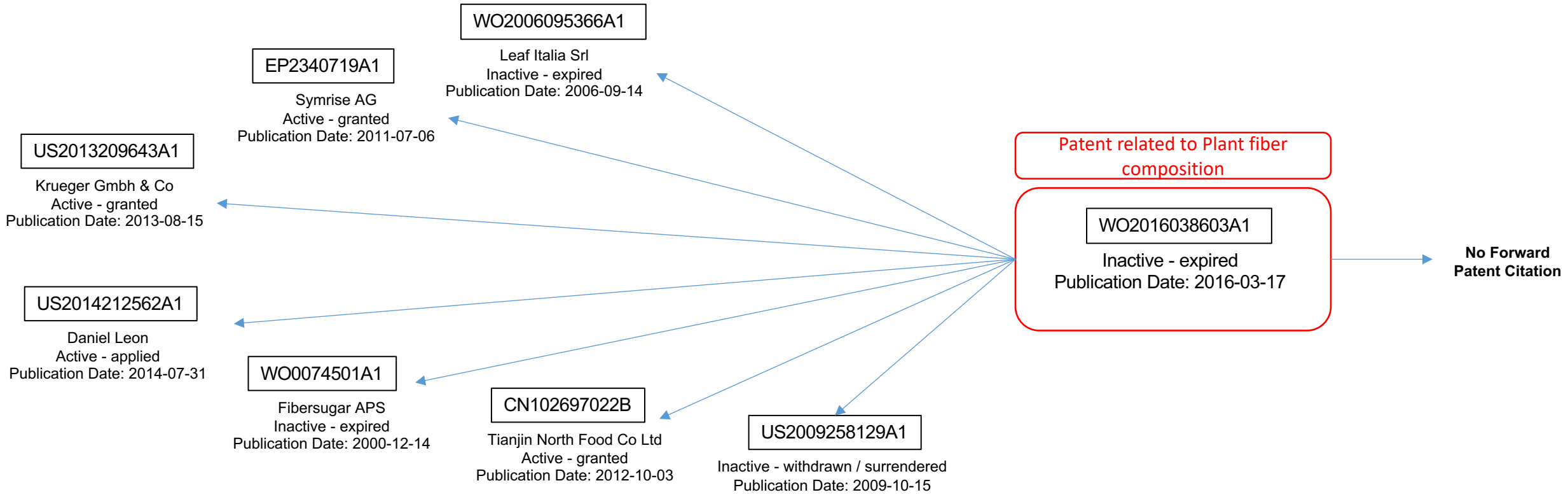
Thaumatin + plant fibers (2/2)

Citation Tree

❑ **Citation tree helps to understand the strength of the technology based on count of companies or universities taking help form the inventive technology.**



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Note that citation tree has been provided for top ten ranked solutions only.

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8.2 Thaumatin + dextrin/ cyclodextrin **

(Rank 3)

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Thaumatin + dextrin/ cyclodextrin (1/2)

Solution

The solution to the problem is invented by HA KEUM YUN; NAM EUN JUNG; KIM JIN HEE; KIM DOO KYUNG

Patent Published in 2018

Application in food & beverages.

- **The present invention aims to provide a thaumatin composition which is a sweetener that reduces obesity of an ingestor and prevents diabetes and tooth decay.**
- **The method of masking the bitter taste using the bitterness masking tonic composition and the thaumatin composition according to the present invention is characterized by comprising 85 to 95 parts by weight of dextrin, And 1800 to 2000 parts by weight of cyclodextrin.**
- **Sweetness is felt later than sugar, and the duration of sweetness is long. pH is 2.7 ~ 7.0, and it is very stable to heating, so there is no decrease in the degree of sweetness even after heating at 80 ~ 100 ° C, and separation, precipitation, and opacity do not occur in the acidic region.**

Evaluation items		Likelihood	Bitter intensity	bitter Likelihood	Likelihood	First taste
Oriental Drink 1	2.5	3.0	4.5	2.0	3.0	3.0
Oriental Drink 2	3.5	4.0	2.0	4.0	4.0	4.0
Oriental Drink 3	3.0	4.0	2.0	4.0	4.0	4.0
Oriental Drink 4	3.0	3.5	3.0	3.5	3.5	3.5

- Content of the mixed powder of thaumatin, dextrin and cyclodextrin was varied in the health drink using the mixture of Angelica gigas Nakai concentrate with strong bitterness and the mixed extract of herbal medicine.
- The sensory evaluation of the **herbal drink thus produced confirmed the bitter taste reduction effect of the mixed composition of thaumatin, dextrin and cyclodextrin**, and the results are shown in Table.
- **As shown in the Table, when 1.0% or more based on the total weight of the mixed composition of thaumatin, dextrin and cyclodextrin was added, the effect of masking the bitter taste peculiar to the herbal medicine was observed, It has a positive effect on flavor taste, overall flavor and so on, thus helping to improve overall product quality.**
- As in the case of [Example 3], the red ginseng beverages having a bitter taste were prepared by adding different amounts of the mixed powders of thaumatin, dextrin and cyclodextrin.
- The sensory evaluation of the red ginseng beverage thus produced confirmed the bitter taste reduction effect of the mixed composition of thaumatin, dextrin and cyclodextrin, and the results are shown in Table - 5) Very good, 4) Good, 3) Moderate, 2) Disliking, 1) Very strong, 5) Strength evaluation: Very strong , 4-strong, 3-normal, 2-weak, 1-very weak)
- **As shown in Table, when the mixed composition of thaumatin, dextrin and cyclodextrin was added in an amount of 0.5% or more based on the total weight, the effect of masking the bitter taste unique to red ginseng was obtained, It has a positive effect on flavor taste, overall flavor and so on, thus helping to improve overall product quality.**
- **The composition (powder) in which thaumatin, dextrin and cyclodextrin are mixed is preferably 1% by weight when mixed with herbal medicines and 0.5% by weight when mixed with red ginseng beverages. It is preferable that the powder mixed with thaumatin, dextrin and cyclodextrin is put into a mixing tank having a solvent such as herbal medicine or red ginseng beverage and then filled in a liquid state by treating the mixture at 85 to 95 DEG C and 2500 to 3000 rpm for 25 to 30 minutes.**

Source

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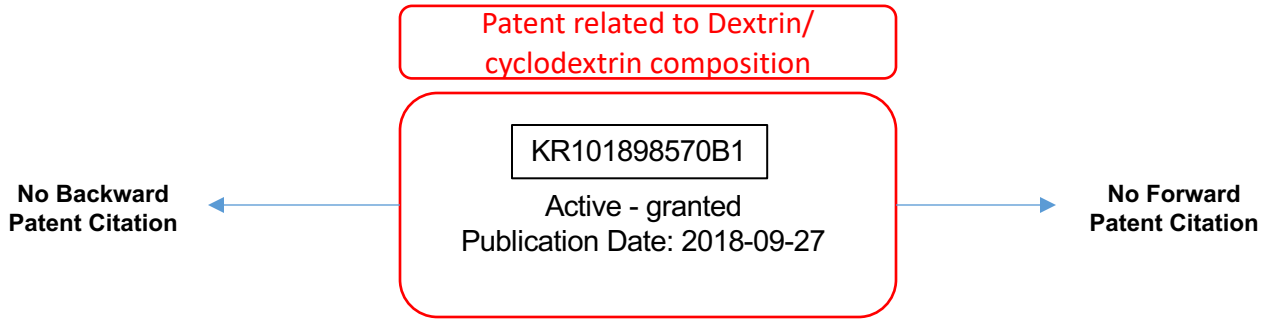
Thaumatin + dextrin/ cyclodextrin (2/2)

Citation Tree

❑ **Citation tree helps to understand the strength of the technology based on count of companies or universities taking help form the inventive technology.**



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8.3 Protein sweetener comprising gelatin **

(Rank 12)

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Protein sweetener comprising gelatin (1/4)

Solution

The solution to the problem is invented by International Additives Ltd

Application in food & beverages.

Patent Published in 1981

- **The invention relates to a sweetening composition which comprises gelatin intimately mixed with a protein sweetener selected from the group consisting of monellin and thaumatin. The ratio by weight of gelatin to protein sweetener is 1:1 to less than 100:1. The preferred ratio of gelatin to protein sweetener is less than 20:1 i.e. from 1:1 to 5:1. The gelatin used is Type A gelatin and has a Bloom strength of greater than 200.** The sweetening composition contains at least **one edible acid which is selected from the group consisting of citric, malic, fumaric and mucic acids**. The composition containing the protein sweetener in combination with at least one component selected from the group consisting of **other sweeteners, taste modifiers and flavoring agents.** The composition can be in a form selected from the group consisting of powders, tablets, granules, dragees, semi-solids and liquids.
- In the preparation process, **the pH of the solution is adjusted to be from 2.5 to 2.9 by addition of edible acid.** The gelatin is dissolved in portable water containing the appropriate amount of an edible acid to give the required pH, and then the protein sweetener is added. **In preparation, the water is moderately heated to dissolve the gelatin and then cooled to below 40° C, before the protein sweetener is added. The invention seeks to limit the disadvantages of peptide sweeteners and broaden their application in sweetening compositions.**
- **It has been discovered that gelatin can promote heat stability in sweetening compositions containing peptide sweeteners.**
- **Preferred forms for the compositions are low calorie sweeteners for hot food or beverages, including tea and coffee. An important factor for the preparation of heat-stable compositions is the correct pH of the solution formed. It is known that the sweetness of thaumatin is pH-dependent and that thaumatin exhibits optimum sweetness over the pH range of 2 to 10. For the best results with peptide sweeteners in general, the invention find the pH of the solution to be dried should be adjusted to be from 2.5 to 2.9, preferably pH 2.7. The pH can be adjusted by any food-grade acid, but the best results are obtained when using one or more of citric, malic, fumaric and mucic (galactaric) acids.**
- Saccharin may, however, be added to the compositions containing protein sweeteners in order to present a sweetness profile with a more rapid onset. Alternatively, aspartame (another peptide sweetener) may be added.

Greater the amount of gelatin, the lower the reduction in sweetness intensity when the composition is heated. The stabilizing effect obtained will also depend on the final concentration of the sweetening composition in the product, **as well as other factors such as pH**.

Decrease in the amount of gelatin, much below the ratio of 3:2, appears to lead to adverse effects on the heat stability of the sweetener, and accordingly a preferred minimum ratio of gelatin to sweetener is 1:1.

Source1

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Protein sweetener comprising gelatin (2/4)

Tests and Results

- As assessed by a taste panel, **the inventors find that a particularly suitable proportion of gelatin to sweetener is at least 3 parts of gelatin to 2 parts of sweetener by weight. The amount of gelatin can be increased without any loss of sweetness or other adverse effect on the properties up to a gelatin to sweetener ratio of 100:1,** although economic reasons make large amounts of gelatin undesirable and inventors thus prefer a ratio of less than 20:1, more preferably less than 5:1. The following examples are given to illustrate the present invention. In these examples, a taste panel was used to estimate sweetness, as is conventional. **The panel assessed which of a series of standardized sucrose solutions had the same sweetness intensity as the sample (i.e. which solution was as sweet as the sample).** The ratio of the concentration of the isosweet sucrose solution to the concentration of the sample solution, which may alternatively be expressed as the dilution of the sample solution relative to the sucrose solution, then gives the number of times the material under test is sweeter than the sugar at the concentration of the sample in the sample solution. From such figures, the percentage sweetness retained after exposure to heat can be calculated. **The panel found, for example, that the sweetness of 0.002% (w/v) thaumatin solution at room temperature was equal in sweetness to 6.2% sucrose. The thaumatin was therefore 3100 times sweeter than sucrose on a weight basis and 2.0×105 times sweeter on a molar basis (the molecular weight of sucrose is 342 and that of thaumatin is about 22,000). In tea or coffee, the relative sweetness of thaumatin is appreciably less: this reduction is a known phenomenon and seems to be due to interaction with caffeine and/or tannin present in the drink. Knowing the end-use of the composition, there is little difficulty in formulating a composition which in practice has the desired sweetening power.**

- **EXAMPLE 1 - Thaumatin-gelatin low calorie sweetening composition.**

  - 0.028 g citric acid was added to 12 ml distilled water to give a pH of 2.7. 0.120 g gelatin (prepared by Sigma Chemical Company from swine skin, approximately 300 Bloom) was then dispersed in the acid solution using even and slow mixing while at the same time heating the solution to 42° C. **The gelatin dissolved once the temperature reached 42° C. The solution was thereafter cooled down to 32° C and 0.080 g of thaumatin added.** Slow mixing gave a homogenous clear solution which was dried as a thin layer exposed to air of temperature 45° C. Freeze drying can be used as an alternative drying method.The resultant dried powder obtained after grinding weighed 0.2 g and was approximately equal in sweetness to 200 g of sucrose. The powder did not appreciably lose sweetness when dissolved in hot water (about 90° C.), as shown by the following test: Drinking water at 97°-98° C. (100 ml aliquots) was poured onto 5 mg samples of the described composition (containing 2 mg thaumatin) in plastics beakers. The resulting solutions were allowed to cool to 62° C. and assessed for sweetness in comparison with standardized sucrose solutions. If no sweetness had been lost, the solutions should have been equal in sweetness to a 6.2% sucrose solution**. The assessed sweetness was, in fact, equal to that of a 5% sucrose solution, giving a sweetness reduction of 19.4%. Control samples of 2 mg thaumatin had no sweetness detectable. In a similar experiment, water at 92° C. gave a sweetness equivalent to 6.2% sucrose, i.e. no loss, while controls lost nearly all their sweetness. A similar test was carried out using aspartame. The loss was negligible at temperatures from 80° to 98°, while controls lost 25%-30% at 97°-98° C.**

Source1

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Protein sweetener comprising gelatin (3/4)

Tests and Results

- **EXAMPLE 2 - A free flowing powder of a low calorie sweetening composition**
  - 0.025 kg of a heat stable thaumatin-gelatin sweetening composition was prepared in accordance with the procedure of Example 1, and 0.100 kg powdered sodium saccharin and 1.000 kg powdered glucuronic acid were then added. **The resultant free flowing powder, weight 1.125 kg, possessed a taste profile comparable to sucrose.**

- **EXAMPLE 3 - Sweetening compositions for tea and coffee**
  - Tablets were prepared in a conventional manner using a formulation such that each tablet contains: Thaumatin-gelatin sweetening composition of Example 1 (5 mg); Saccharin (14 mg); Glucuronic acid (38 mg); Sucrose (54 mg); Gum Arabic (3 mg); and Magnesium sterate (1 mg) = Total 115 mg. The sucrose helps to render the powder free-flowing for tableting and the gum arabic and magnesium stearate respectively help to bind and lubricate the tablets. The tablets are each equivalent in tea and coffee to 4.4 g sucrose and give to tea and coffee a pleasant taste which is preferable to and superior to that obtained with conventional saccharin tablets. In a variation of the above formulation, the 5 mg of thaumatin--gelatin composition of Example 1 is replaced by 12.5 mg of a 2:3 monellin--gelatin composition prepared by the procedure of Example 1 using monellin instead of thaumatin. The components and preparations are otherwise the same and give tablets with similar advantages properties. **In a further variation, the 14 mg saccharin is replaced by 30 mg aspartame and a similar product is obtained. The aspartame is preferably in the form of a gelatin-aspartame composition according to the invention. Alternatively, the sweetness may be added in the form of a thaumatin/aspartame/gelatin composition.**

- **EXAMPLE 4 - Readily dissolving dipeptide-gelatin low calorie sweetening composition**
  - To 1.2 l distilled water was added 28 g fumaric acid. 120 g gelatin was dispersed in the solution by even, low speed mixing and simultaneous heating to 42° C. To the resultant solution was added 80 g of aspartylphenylalanine methyl ester; slow mixing gave a homogeneous clear solution. The resulting solution was dried to give a dried powder. **There was no loss of sweetness when samples of the present product were dissolved in hot water at 80° to 97° C.**

Source1

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Protein sweetener comprising gelatin (4/4)

Application

- Potentials of gelatin in sweetening compositions should be explored more.
- Gelatin in combination with protein sweeteners can affect beneficial characteristics other than thermal stability, should be explored.

Conventional Solutions

A disadvantage common to the peptide sweeteners is the loss of sweetening power with increase in temperature.

- Thaumatin and monellin are heat sensitive and undergo irreversible heat denaturation with accompanying loss of sweetness.
- Thaumatin loses 30% of its sweetness when maintained for 15 minutes at 60° C., 52% of its sweetness in 5 minutes at 75° C., 75% of its sweetness in 5 minutes at 80° C. and 100% of its sweetness in 1 minute at 92° C.

Advantages

The present compositions retains the sweetening power.

Gelatin does not deleteriously affect the sweetness of thaumatin and monellin, and it is an especially unexpected finding that gelatin can promote their heat stability.

Comment

- The invention discloses a heat-stable sweetening composition containing a peptide sweetener such as thaumatin is obtained by mixing the sweetener with gelatin at a weight ratio of gelatin to sweetener of less than 100:1. Solid forms can be prepared by drying a co-solution of the sweetener and gelatin in water, preferably containing an edible acid.
- The invention seeks to limit the disadvantages of peptide sweeteners and broaden their application in sweetening compositions.

Source1

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8.4 Sweetener Composition containing anti-foaming agent **

(Rank 13)

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Sweetener Composition containing anti-foaming agent (1/3)

TATE & LYLE

Solution

The solution to the problem is invented by Tate and Lyle

Patent Published in 2015

Application in food & beverages.

- **The solution here discloses about a sweetener composition comprising at least one high potency sweetener, and at least one anti-foaming agent, wherein the at least one high potency sweetener contains hydrophilic and hydrophobic structural moieties.**
- **High potency sweetener is selected from the group consisting of** abrusoside A, alitame, aspartame, baiyunoside, **brazzein, curculin,** cyclocarioside I, glycyphyllin, glycyrrhizic acid, a glucosylated steviol glycoside, hernandulcin, N-[N-[3-(3-hydroxy-4-methoxyphenyl)propyl]-L-[alpha]-aspartyl]-L-phenylalanine 1-methyl ester, N-[N-[3-(3-hydroxy-4-methoxyphenyl)-3-methylbutyl]-L-[alpha]-aspartyl]-L-phenylalanine 1-methyl ester, a Luo Han Guo extract, **mabinlin**, N-[N-[3-(3-methoxy-4-hydroxyphenyl)propyl]-L-[alpha]-aspartyl]-L-phenylalanine 1-methyl ester, monatin, **monellin**, mukurozioside, neohesperidin dihydrochalcone, neotame, osladin, periandrins, phlomisosides, phloridzin, phyllodulcin, polypodoside A, pterocaryoside A, pterocaryoside B, an ent-kaurane sweetener, **thaumatin** and trilobatin.
- **Anti-foaming agent comprises** one or more selected from the group consisting of **a fatty acid, a fatty acid ester, a silicone oil, silicon dioxide, an alkyl-substituted silicon dioxide, lecithin, a vegetable oil , propylene glycol mono and diesters of fatty acids, propylene glycol alginate, calcium alginate, mineral oil, odourless light petroleum hydrocarbons, petrolatum, petroleum waxes, synthetic isoparaffinic petroleum hydrocarbons, synthetic petroleum wax, paraffin wax, microcrystalline wax, tallow, oxidized tallow, sulfated tallow, oleomargarine, lard, butter, oxystearin, a fatty acid metal salt, ethylene oxide polymer, copolymer condensates of ethylene oxide and propylene oxide, polyethylene glycol, polypropylene glycol, polyethylene glycol (400) dioleate, sorbitan monostearate, polysorbate 60 (polyoxyethylene (20) sorbitan monostearate), polysorbate 65 (polyoxyethylene (20) sorbitan tristearate), polysorbate 80 (polyoxyethylene (20) sorbitan monooleate), n-butoxypolyoxyethylene polyoxypropylene glycol, polyoxyethylene (600) dioleate, polyoxyethylene (600) monoricinoleate and polyoxyethylene (40) monostearate.**

- **Anti-foaming agent has a hydrophilic-lipophilic balance value of less than or equal to 10.**
- **High potency sweetener to the at least one anti-foaming agent is from about 0.004:1 to about 300:1 on a weight to weight basis.**
- **The composition is formulated as a syrup, in powder form, in tablet form, as granules, or as a solution.**
- **The composition formed can be used in food product, a beverage product, a pharmaceutical product, a nutritional product, a sports product, or a cosmetic product.**
- **The beverage product has an acidic pH (2.0 to about 6.5).**

Source

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Sweetener Composition containing anti-foaming agent (2/3)

Tests

Sensory Evaluation:

- Panellists were presented with a sample of Formula A. Sweetened iced tea, water, and Formula A sweetened iced tea with silicone oil.
- Panellists were then asked to describe the difference in temporal profile between the samples.
- **Silicone oil in 499.5 g of coffee was obtained by brewing two 8 oz cups of coffee in a KeurigRTM Coffee maker**.
- **To this solution 0.5 g of Formula A was added to obtain a 1000 ppm solution of Formula A sweetened coffee.**
- **From this solution a 50 ppm solution containing BIOSILRTM AF720E-20% food grade anti-foam emulsion was prepared.**
- **This yields a 10 ppm solution of dimethylpolysiloxane, which is the GRAS level for use in beverages**.
- Before tasting, the five panellists were instructed to pay close attention to the overall temporal including **sweetness onset and sweet linger**.
- **The panellists were then presented with a sample of Formula A sweetened coffee, water and Formula A**
- **The panellists were then asked to describe the difference in temporal profile between the samples.**

Temporal Profile:

- Method The temporal profile determined using a trained descriptive panel.
- **Panellists had several orientation rounds of the test samples as well as other samples to familiarize themselves with the protocol and the samples.**
- **The tests were conducted as complete block designs in 3 replicates with the trained panel and were done over two testing days (one for each formula set).**
- **The presentation order was rotated. The solutions were served in 2 fluid ounce soufflé cups labelled with 3-digit codes.**
- Panellists were instructed to sample the product by placing the sample in their mouths and swallowing or spitting out the sample immediately while starting their intensity rating for sweetness at the same lime using EyeQuestion.
- **Intensity ratings for sweetness were collected for 2 minutes, Panellists had a two minute wait time between samples and at least a 10 minute break in-between repetitions.**
- **Panellists cleaned their palates with bottled water and unsalted crackers.**
- Time to peak was compared across samples to determine if addition of anti-foam or fructose can improve time course of Formula A.

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Sweetener Composition containing anti-foaming agent (3/3)

Results

Sensory Evaluation:

- **One panellist reported that the silicone oil containing sample resulted in a faster sweetness onset than the control**. **Two panellists reported less sweet linger with the silicone oil containing sample. One of these panellists reported that the silicone oil containing sample more quickly reached maximal sweetness compared to control. This result was not exactly the same as faster onset.** One panellist could not find a definitive difference between samples, although it was noted that the silicone oil containing sample had a thicker mouthfeel. The final panellist reported that the silicone oil sample was not sweet. Silicone Oil in Tea Three of the five panellists reported that the anti-foaming agent treated sample reduced sweet linger. **Three of the five panellists reported a faster sweetness onset in the anti-foamed sample. One panellist reported that the sample with the anti-foaming agent delayed onset.**

Temporal Profile:

- **Fructose levels of 4500 ppm to Formula A in neutral pH changes the temporal profile by reducing sweetness onset based on the difference in response for the first seconds.** The addition of 160 ppm levels of fructose to Formula A in neutral pH did not reduce sweetness onset (similar to what was previously observed with 80 ppm fructose to Formula A in neutral pH). **Neither the 160 ppm or 4500 ppm fructose addition reduced sweetness linger**. **The addition of 160 ppm and 4500 ppm levels of fructose to Formula A in an acid medium changed the temporal profile related to improving sweetness onset based on the difference in response for first 20 seconds.** There was no difference in sweetness linger with the addition of fructose to Formula A. Silicone oil (anti-foaming agent) was added to both the 160 ppm and 4500 ppm levels of fructose with Formula A in neutral pH, there was a change in the sweetness linger profile of Formula A, with a reduced linger intensity after the peak in sweetness intensity. **The effect was more dramatic for the 160 ppm fructose addition versus the 4500 ppm (the 4500 ppm loses its linger difference over control after 40 seconds).**
- **Both the 160 ppm and 4500 ppm prototypes have improved overall sweetness onset profiles relative to the Formula A control based on the difference in response for the first 20 seconds.**

❑ The method is applicable for producing composition comprising protein sweeteners and having reduced delay in sweetness onset and reduced sweetness linger of the sweetener.

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8.5 Gentian additive (<50 PPM) Composition (Rank 23)

Reduction of lingering/ aftertaste of protein sweetener

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Gentian additive (<50 PPM) Composition by Concentrate Manufacturing Company

Solution

The solution to the problem is invented by Concentrate Manufacturing Company

Patent Published in 2016

Application in beverages, tea, carbonated soda, juice, coffee, sport drink.

- The Concentrate Manufacturing Company of Ireland was set up in 1985.
- The invention relate to **beverage compositions, concentrated and ready-to-drink formulations sweetened with non-nutritive sweetener and a bitterant in an amount sufficient to reduce the lingering sweet aftertaste of the non-nutritive sweetener(s).** The **non-nutritive sweetener comprising rebaudioside A,** steviol glycosides, Stevia rebaudiana extract, **thaumatin, monellin, brazzein**, D-alanine, **monatin**, and a mixture of any of them.
- The **bitterant comprises gentian**. Concentration of **the gentian component is less than 50 parts per million (specifically 6.25 parts per million and 12.25 parts per million).**
- The gentian component is selected from the group consisting of **gentian, gentian extract, gentian salt, gentian alkaloid, gentian derivative**, and a combination of any of them.
- **Combining a non-nutritive sweetener having a lingering sweet aftertaste with a bitterant** to create a mixture such that when the mixture is contained in a beverage, **the bitterant is present in an amount sufficient to reduce the lingering sweet aftertaste of the non-nutritive sweetener**.
- The beverage is a **diet tea beverage, a reduced calorie tea beverage, a diet carbonated soda drink, a reduced calorie carbonated soda drink, a near water drink, a juice drink, a ready-to-drink coffee drink, or a sport drink**.

Tests

A 10% stock solution of **gentian solid extract** (91.26% solids, a **product of NATUREX Inc**.) was dissolved in propylene glycol. A 5-liter syrup for use in making a finished beverage was also prepared. Exemplary beverage formulations and their respective ingredients for making a syrup. A taste panel consisting of five tasters evaluated the finished beverages.

Results

Results indicated that **when the concentration of gentian extract in the finished beverage was increased, the sweet lingering aftertaste was reduced**. In finished beverages where the gentian extract concentration was from 6.25 ppm to 12.5 ppm, the sweet lingering aftertaste of rebaudioside A was almost entirely eliminated. As the concentration of gentian extract was increased from 25 ppm to 50 ppm, the beverages yielded a corresponding increase in bitter taste (i.e., gentian flavor was perceived). A taste panel consisting of five tasters evaluated the finished beverages. **Results indicated that when the concentration of gentian extract in the finished beverage was increased, the Sweet lingering aftertaste was reduced. In finished beverages where the gentian extract concentration was from 6.25 ppm to 12.5 ppm**, the Sweet lingering aftertaste of rebaudioside A was almost entirely eliminated. As the **concentration of gentian extract was increased from 25 ppm to 50 ppm, the beverages yielded a corresponding increase in bitter taste (i.e., gentian flavor was perceived).**

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8.6 Thaumatin + Aldohexuronic Acids ** (Rank 24)

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Thaumatin + Aldohexuronic Acids

The solution to the problem is invented by Tate & Lyle Ltd.

TATE & LYLE

Patent Published in 1978

Solution

- **The reference here discloses about a sweetener composition containing at least one sweetener selected from the group consisting of the protein sweetener thaumatin, the protein sweetener monellin and saccharin, together with a modifier selected from the group consisting of aldohexuronic acids and salts, amides and lactones thereof in an amount sufficient to reduce the sweet aftertaste of the protein sweeteners or the bitter aftertaste of the saccharin.**
- **Modifier is selected from the group consisting of D-glucuronic acid, D-glucuronolactone, sodium D-glucuronate, glucuronamide, D-galacturonic acid, D-mannuronic acid and mannuronolactone.**
- **The ratio by weight of modifier to saccharin is from about 1:10 to about 1:1.**

Application in food & beverages.

Tests

Sensory Evaluation:

- The sweetness of some compositions were evaluated by a panel of experienced tasters against sucrose as a standard. The sweetness of the individual ingredients was also evaluated. **Each material was dissolved in water at a neutral pH value to give a range of solutions each of a different concentration and the panel was asked to match the sweetness of the resulting solutions to that of a standard sugar solution. The panel was asked to compare the sweetness of a range of sodium saccharin solutions of different concentrations with that of 2% and 5% solutions of sucrose.**

Advantages

The composition produced has reduced the onset of unpleasant aftertaste.

Results

Sensory Evaluation:

- **The aldohexuronic acids and derivatives thereof were found to have no detectable sweetness. They assessed the sweetness of sodium saccharin as 510 times that of sucrose when the 2% sucrose solution was used as standard and 410 times that of sucrose when the 5% sucrose solution was used as standard.** This result is in accordance with the known decrease in the relative sweetness of saccharin and other sweeteners such as xylitol with increasing concentration. **The thaumatin used also showed a decrease in relative sweetness with increasing concentration, although the decrease was not as pronounced as that of saccharin. When solutions of thaumatin were assessed against a 5% solution of sucrose, the panel assessed the sweetness of thaumatin as 3,500 times that of sucrose. When the solutions were assessed against a 15% solution of sucrose, the panel assessed the sweetness of thaumatin as 1,800 times that of sucrose. The sweetness profile is more rounded and unpleasant aftertastes are minimized.**

Source

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8.7 Binding method of Rebaudioside and Thaumatin/ Brazzein on different taste receptors by Suntory holdings (Rank 25)

Reduction of lingering/ aftertaste of protein sweetener

Back to Ranking

Binding method of Rebaudioside and Thaumatin/ Brazzein on different taste receptors by Suntory holdings

The solution to the problem is invented by Suntory Holdings

Patent Published in 2020

SUNTORY

- **Composition of Rebaudioside/ stevioside + Thaumatin/ Brazzein** - A patent (US20200107568A1) filed by **Suntory Holdings Ltd**. The patent disclosing if high intensity sweeteners (rebaudioside A, rebaudioside D, rebaudioside M) binds to VFT part of a taste receptor (Site A), and thaumatin, brazzein binds to at least one site selected from following to **reduce sweet lingering**.
  - A linking part of a taste receptor (Site B)
  - A transmembrane domain of a taste receptor (Site C)
  - A membrane transporter protein of a taste cell (Site D)

Application in beverages, tea, carbonated soda, juice, coffee, sport drink, health drink, dairy drinks.

	Sweet lingering index value
Reference solution α2 (Thaumatin)	24.3
Reference solution β1 (Glucose)	39.8
Weighted average value of reference solutions α2 and β1	32.1
Sample solution γ4	37.6

Combination of stimulated sites	Components	Reducing effect on sweet lingering
Site A + Site D	Rebaudioside D + glucose	Yes (46%)
Site A + Site B	Rebaudioside D + thaumatin	Yes (42%)
Site A + Site A (Comparative Example)	Rebaudioside D + fructose	No (7%)
Site B + Site D	Thaumatin + glucose	Yes (17%)

Source

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8.8 Solutions on Rubisco protein (Rank 26)

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High-potency sweetener composition with rubisco protein (1/4)

The solution to the problem is invented by Coca Cola

Solution

Patent Published in 2011

- Natural caloric sweetener compositions, such as sucrose, fructose, and glucose, provide the most desirable taste to consumers, but they are caloric.
- Health trends have promoted an increased use of non-caloric high-potency sweeteners in consumer diets.
- Numerous natural and synthetic high-potency sweeteners are non-caloric; however, they exhibit sweet tastes that have different temporal profiles, maximal responses, flavor profiles, mouthfeels, and/or adaptation behaviors than that of sugar for example, the sweet tastes of natural and synthetic high-potency sweeteners are slower in onset and longer in duration than the sweet taste produced by sugar and thus change the taste balance of a food composition.
- Because of these differences, use of natural and synthetic high-potency sweeteners to replace a bulk sweetener, such as sugar, in a food or beverage, causes an unbalanced temporal profile and/or flavor profile.
- In addition to the difference in temporal profile, high-potency protein sweeteners generally exhibit **(i) lower maximal response than sugar, (ii) off tastes including bitter, metallic, cooling, astringent, licorice-like taste, etc., and/or (iii) sweetness which diminishes on iterative tasting.**
- It is well known to those skilled in the art of food/beverage formulation that changing the sweetener in a composition **requires re-balancing of the flavor and other taste components (e.g., acidulants).**
- If the taste profile of natural and synthetic high-potency sweeteners could be modified to impart specific desired taste characteristics to be more sugar-like, the type and variety of compositions that may be prepared with that sweetener would be expanded significantly.
- Accordingly, it would be desirable to selectively modify the taste characteristics of natural and synthetic high-potency sweeteners.
- **It also would be desirable to improve the taste of ingestible compositions that include functional ingredients to promote their use and the resulting health benefits.**
- The reference here discloses about **improving the temporal and flavor profile by imparting a more sugar-like profile, more particularly, comprising a sweetener composition having at least one functional ingredient selected from the group consisting of rubisco protein, rubiscolin, rubiscolin derivatives.**

Application in beverages.

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High-potency sweetener composition with rubisco protein (2/4)

Solution

- The solution here discloses about a sweetener composition comprising one **functional ingredient selected from the group consisting of a rubisco protein, a rubiscolin, a rubiscolin derivative**.
- Rubiscolin protein is selected from the group consisting of **rubiscolin-5, rubiscolin-6**,
- The **rubiscolin derivative comprises an amino acid sequence selected from the group consisting of Tyr-Pro-Ile-Asp-Leu-Phe (SEQ ID NO: 3), Tyr-Pro-Met-Asp-Leu-Phe (SEQ ID NO: 4), Tyr-Pro-Leu-Asp-Leu-Val (SEQ ID NO: 5), Tyr-Pro-Ile-Asp-Leu-Val (SEQ ID NO: 6), Tyr-Pro-Met-Asp-Leu-Val (SEQ ID NO: 7), an ACE inhibitory peptide.**
- **Rubisco protein ensures ACE inhibition action.**
- The composition further comprises rebaudioside A and a sweet taste improving polyol (erythritol, maltitol, mannitol, sorbitol, lactitol, xylitol, inositol, isomalt, propylene glycol, glycerol).
- The rebaudioside A composition and polyol are present in the sweetener composition at a weight ratio in the range of about 1:50 to about 1:800

RuBisCO protein has 80% higher solubility at pH values lower than 4.0 or higher than 5.5. Source

Source

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High-potency sweetener composition with rubisco protein (3/4)

Tests

Sensory evaluation:

- Sensory evaluation of the samples prepared was carried out.
- In this test protocol, **none of the samples were swallowed**.
- **All samples were expectorated and the mouth was rinsed with water after the tasting**.
- Immediately upon sensing maximal sweetness, the sample was expectorated, **the mouth was rinsed with water and the rate of sweetness decay ("Sweetness Linger") was measured, where attention was focused on the sweetness 3-4 min after the water rinse**.
- After sample tasting was complete, **a salty oyster cracker was chewed followed by a water rinse**, and at least 5 minutes followed before tasting the next sample.
- The sweetness linger was rated by a panel of experts in the sensory evaluation of foods and beverages using the following scale: **0=no sweetness linger, 1=very slight sweetness linger, 2=slight sweetness linger, 3=moderate sweetness linger, 4=moderately high sweetness linger, 5=high sweetness linger**.
- The comparison taste test was performed between two controls and addition of sweet taste improving additive on the onset and/or sweetness linger.

Results

Sensory evaluation:

- The "Sweetness Linger" **rating for sucrose observed by this protocol is defined as 0.**
- **The Sweetness Linger of a 500 ppm of REBA (Rebaudioside A) control sample is defined as 5.**
- Experimental samples were tasted, always allowing sufficient time between samples to ensure re-equilibration of the sensory system.
- Re-tasting of control samples during the course of the experiment was allowed and encouraged.
- **The sweetness linger rating of this solution was determined to be 5.**
- **The sweetness linger rating of this control sample was determined to be 0**.

Source

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High-potency sweetener composition with rubisco protein (4/4)

Application

- The method is applicable for production of a functional sweetener compositions comprising functional ingredient, such as rubisco protein, rubiscolin, rubiscolin derivatives, ACE inhibitory peptide, and combinations that can improve the tastes of non-caloric or low-caloric high-potency sweeteners by imparting a more sugar-like taste or characteristic.

Conventional Solutions	Advantages
The conventional Sweeteners were high in calorie content.	The sweetener composition comprises no or very low quantity of calories.

Source

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8.6 Sweetening Compositions Containing Arabinogalactan **

(Rank 28)

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Sweetening Compositions Containing Arabinogalactan (1/2)

Solution

The solution to the problem is invented by TATE & LYLE LTD

Patent Published in 1980

TATE & LYLE

Application in food & beverages.

- **The solution discloses about a sweetening composition comprising** at least **one sweetener** selected from the group consisting of the **protein sweetener thaumatin**, **the protein sweetener monellin and saccharin together with a sweetener after-taste reducing amount of arabinogalactan.**
- **The ratio of arabinogalactan to said sweetener being such that the concentration of arabinogalactan does not detract from sweetness level or impart body or mouth feel or exceed 2.5% of an ingestible product or oral composition** when the composition is added to said ingestible product or oral composition in an amount effective to sweeten said ingestible product or oral composition.
- Saccharin is present in the absence of said protein sweeteners the ratio of arabinogalactan to saccharin does not exceed 1:1.

- The sweetener is at least one protein sweetener used in the absence of saccharin, and the weight ratio of arabinogalactan to protein sweetener is from about x:12 to about x:70 where x is the number of times sweeter the protein sweetener is as compared with sucrose as a concentration of 5% by weight.

- **A sweetness modifier selected from the group consisting of xylitol, D-arabitol, D-galactose, L-gulose, D-fucose, lactulose, glucoheptose, and D(+)-galactosamine.**

- **A carrier or diluent selected from the group consisting of a maltodextrin, starch, a nutritive protein, sucrose, ethanol, glycerol and an edible oil.**

- **The sweetness profile of the composition is more rounded and unpleasant after-tastes are minimized.**

Source

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Sweetening Compositions Containing Arabinogalactan (2/2)

Tests

- **The sweetness of the compositions was assessed by a panel of experienced tasters against sucrose as a standard.**
- The sweetness of the individual ingredients was also evaluated.
- **Each material was dissolved in water at a neutral pH value to give a range of solutions each of a different concentration and the panel was asked to match the sweetness of the resulting solutions to that of a standard sugar solution.**
- **The panel was asked to compare the sweetness of a range of sodium saccharin solutions of different concentrations with that of 2% and 5% solutions of sucrose.**

Results

- **Arabinogalactan was found to have no detectable sweetness but only a typical "gum-like" taste.**
- **Panel assessed the sweetness of sodium saccharin as 510 times that of sucrose when the 2 sucrose solution was used as standard and 410 times that of sucrose when the 5% sucrose solution was used as standard.**
- This result is in accordance with the known decrease in the relative sweetness of saccharin and other sweeteners such as xylitol with increasing concentration.
- **The thaumatin used also showed a decrease in relative sweetness with increasing concentration, although the decrease was not as pronounced as that of saccharin.**
- **When solutions of thaumatin were assessed against a 5% solution of sucrose, the panel assessed the sweetness of thaumatin as 3,500 times that of sucrose.**
- **The solutions were assessed against a 15% solution of sucrose, the panel assessed the sweetness of thaumatin at 1,800 times that of sucrose.**
- The sweetness profile is more rounded and unpleasant after-tastes are minimized.

❑ The method is applicable for producing protein sweeteners compositions with prevention unpleasant after-tastes which is a major problem in conventional protein sweeteners.

Source

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8.10 Improving Sweet Proteins by Using Peptidylarginine Deiminase **

(Rank 29)

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Improving Sweet Proteins by Using Peptidylarginine Deiminase (1/3)

Solution

The solution to the problem is invented by DSM

Patent Published in 2021

Application in food & beverages.

- The reference discloses about the process for modifying a sweet protein or a taste modifying protein, comprising **incubating a sweet protein solution or a taste modifying protein solution with a peptidyl arginine deiminase (PAD).**
- **Sweet protein powder is partly dissolved in water or a buffer solution** by adding the sweet protein powder to water or a buffer solution and allowing the powder to at least partly dissolve in said liquid.
- **Depending on the characteristics of the sweet protein powder it might be needed to mix the powder with the liquid for a certain amount of time optionally using some heat to improve/speed up the dissolving process.** Alternatively, a suspension is prepared in water or a suitable buffer. After the completion of dissolving process incubation step takes place. The step of incubating sweet protein solution or a taste modifying protein solution with a peptidyl arginine deiminase (PAD) can be performed at any suitable pH for any suitable time and with any suitable enzyme concentration.
- **The skilled person is very well capable of establishing a suitable enzyme amount or a suitable incubation temperature or a suitable incubation pH or a suitable incubation time, for instance incubating protein with a peptidyl arginine deiminase at a pH of between 4 and 9, such as a pH of between 5 and 8.5, such as a pH of between 5.5 and 8, such as a pH between 6 and 7, or a pH of between 6.2 and 6.8, for instance at a pH of about 6.5**.
- **A suitable temperature at which protein is incubated with PAD may be between 20 and 60 degrees Celsius, such as a between 30 and 50, or between 35 and 45 degrees Celsius**.

- **Sweet protein or said taste modifying protein is thaumatin, a rapeseed protein (napin), monellin, brazzein/pentadin, mabinlin, egg white lysozyme, miraculin or neocurlin/curculin.**.

- The peptidyl arginine deiminase (PAD) has at least 80% identity to SEQ ID NO:1 , or has at least 80% identity to the mature amino acid sequence of SEQ ID NO:1

- **Method is a capable of reducing the aftertaste of said sweet protein, reducing the time in which the sweetness of said sweet protein is perceived, reducing the time in which the onset of the sweetness is perceived.**

Source

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Improving Sweet Proteins by Using Peptidylarginine Deiminase (2/3)

Tests

Sweetness Time Intensity assessment of rapeseed protein isolate treated with PAD:

- **Aqueous rapeseed protein powder suspensions were made (1000 mL, 2% w/w) in tap water and the pH was adjusted to 6.5 with 4M H_2SO_4. Suspensions were incubated for 2h h at 45°C with and without PAD** addition at different enzyme dosage. **The enzyme was further inactivated, by heating the materials at 65°C**, with a holding time of 5 minutes. A trained panel (n=12) rated the sweet intensity of the samples at several time points: directly after intake, after three seconds the sample was swallowed and the intensity was scored again, and further scoring was at 5, 10, 20, 30, 60 and 120 seconds after swallowing. Samples were evaluated in duplicate and offered according to an optimally balanced design. **The data were analyzed with ANOVA to find significant differences between individual samples; differences with $p<0.05$ were considered as significant.**

Sweetness profile of thaumatin treated with PAD:

- **Thaumatin obtained from Naturex (Talin T-0004) was prepared in water at a concentration of 50 parts per million. To this solution 50 mU PAD/L was added and incubated at 45°C for 2 hours. The enzyme was then inactivated by heating the solution at 65°C**, holding time 5 min. An experienced panel of 10 people tasted the thaumatin solution with and without PAD enzyme treatment. The sweetness intensity changes with the PAD enzyme treatment and the temporal profile of the sweetness with the enzyme addition were similar as described for the rapeseed protein.

Results

- **The PAD enzyme reduces the intensity of sweetness of thaumatin, while the onset of sweetness is faster and the length of the sweet sensation is decreased.**
- **The protein sample treated with PAD enzyme shows a more rapid onset of sweetness** (the sweet perception in the mouth and immediately after swallowing).
- **The sweetness intensity decreases more rapidly in the enzyme treated samples, 5 seconds after swallowing.**

Source

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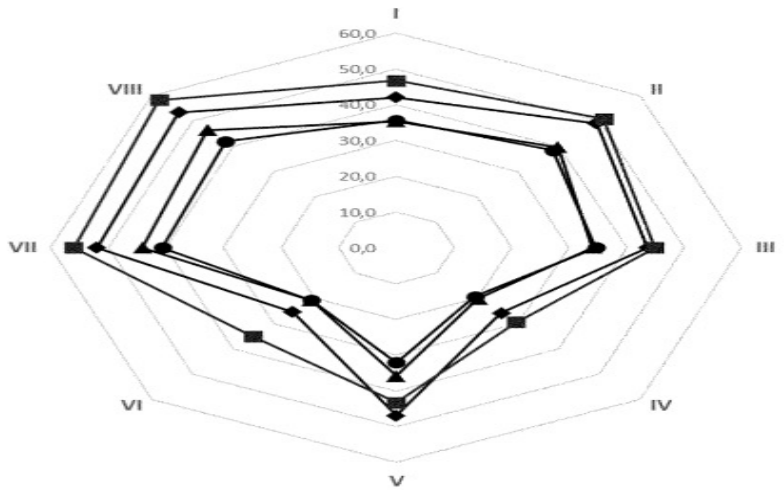
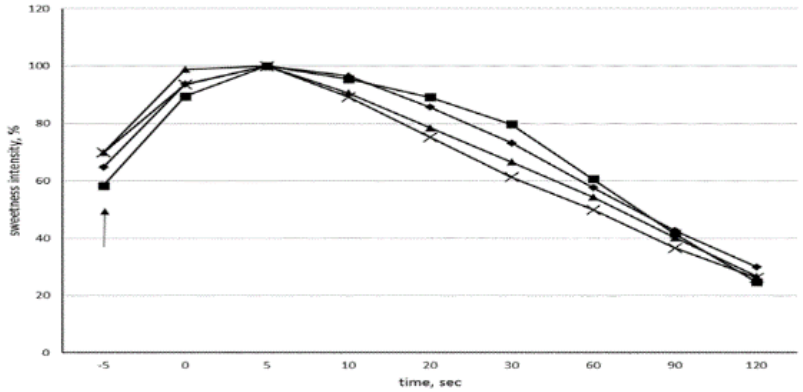
Improving Sweet Proteins by Using Peptidylarginine Deiminase (3/3)

Results

- **Sensory attributes of a 2% solution of rapeseed protein isolate with and without PAD treatm ■: Sensory attributes of rapeseed protein isolate solution untreated with PAD**; ¨ : sensory attrib of rapeseed protein isolate solution treated with 2U PAD per L;▲: sensory attributes of rapeseed pro isolate solution treated with 20 U of PAD per L; · : sensory attributes of rapeseed protein isolate solu treated with 60 U of PAD per L. Sensory attributes are astringency mouthfeel (I), flavor intensity sweet flavor (III), bitter flavor (IV), liquorice flavor (V), bitter aftertaste (VI), length aftertaste (VII), astringent aftertaste (VIII).



- **Development of sweetness intensity of rapeseed protein solutions in time with and without PAD**.■: 2% solution of rapeseed protein isolate, no PAD added; ¨ : 2% solution of rapeseed protein isolate, 2U PAD per L added;▲: 2% solution of rapeseed protein isolate, 20U PAD per L added; x: 2% solution of rapeseed protein isolate, 60 U PAD per L added. X-axis: time (sec), Y-axis: relative sweetness (%) whereby sweetness of each sample was normalized at 100% at 5 seconds after swallowing. The arrow at -5 sec indicates the sweetness perceived directly in the mouth before swallowing, while 0 sec represents the sweetness immediately after swallowing the sample.



- The method is applicable for producing sweet proteins with reduced aftertaste, reduced time in which the sweetness of said sweet protein is perceived, reduced the time in which the onset of the sweetness is perceived.

Source

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