FOOD PRODUCTS HAVING SWEETNESS ENHANCER

Gly-Phe Sweet Taste Enhancement

↑ = enhancement of sweet taste beyond inherent sweetness of compound*  
↓ = suppression of sweet taste below inherent sweetness of compound

* Note that Gly-Phe did not show any inherent sweetness

FIG. 1
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FIELD

[0001] This disclosure generally relates to, among other things, food products having a compound that enhances the sweetness of the food products.

BACKGROUND

[0002] A desire to reduce consumption of conventional sweeteners, such as granulated sugar (sucrose) and high fructose corn syrup, has led to increasing use of low or non-caloric high-intensity sweeteners. However, many non-caloric or low-caloric sweeteners are prohibitively expensive, contain unpleasant off-flavors, or have unexpected and less-than-desirable sweetness profiles.

[0003] Compounds that enhance the sweet taste of sweeteners have been identified and may prove beneficial for improving or intensifying the perceived flavor of sweeteners and may aid in the ability to reach a certain sweetness intensity using reduced concentrations of sweeteners. Accordingly, a sweetness enhancer may allow for the use of less sweetener to achieve a desired sweetness level, which may result in less calories or associated undesirable flavor notes or off-notes.

[0004] Therefore, it is of interest to identify novel sweetness enhancers.

SUMMARY

[0005] This disclosure describes, among other things, the use of the dipeptide, Gly-Phe, to enhance the perception of sweet taste of sweeteners. As described herein, the dipeptide, Gly-Phe, does not elicit a substantial perception of sweetness on its own, but enhances the perception of sweet taste of a sweetener, such as sucrose. At concentrations effective to enhance sweet taste, Gly-Phe produced little to no undesirable or off flavor notes.
In embodiments, a food product is described herein. The food product includes at least one compound that imparts a sweet taste (a sweetener) and a sweetness enhancer comprising Gly-Phe. The food product may also include at least one additional ingredient. Preferably, the sweetness enhancer is present in the food product in an amount effective to enhance a perception of sweetness of the food product. In some embodiments, the sweetness enhancer does not impart a sweet taste on its own at an amount in which it is included in the food product.

In embodiments, the sweetness enhancer is a polypeptide comprising Gly-Phe.

In embodiments, the sweetness enhancer consists of Gly-Phe.

One or more embodiments of the compositions, food products or methods described herein provide one or more advantages over prior compositions, food products or methods. Such advantages will be readily understood from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a graph of mean sweetness values determined by trained sensory panelists of various samples.

FIG. 2 is a graph of mean sweetness values determined by trained sensory panelists of various samples.

DETAILED DESCRIPTION

This disclosure describes, among other things, compounds that enhance the perception of sweet taste or another taste associated with consumption of a sweetener. The compounds comprise the dipeptide Gly-Phe (glycine-phenylalanine). In embodiments, the compounds are used as ingredients in food products to enhance perception of sweet taste. In embodiments, the food products are food products that contain reduced amounts of a sweetener, while imparting a sweet taste typically associated with higher amounts of the sweetener.
In embodiments, a food product includes a sweetener (i.e., a compound that imparts a sweet taste) and a sweetness enhancer comprising a Gly-Phe dipeptide. The sweetness enhancer may be a dipeptide consisting of Gly-Phe. The sweetness enhancer comprising Gly-Phe may be a naturally-derived, may be isolated or purified, or may be synthesized to be identical to a naturally-derived polypeptide comprising Gly-Phe. The food product may include one or more ingredients in addition to the sweetener and the sweetness enhancer comprising a Gly-Phe dipeptide.

As used herein, a "food product" is a food in a form that does not exist in nature. In embodiments, a food product includes at least two edible ingredients, such as a sweetener and a sweetness enhancer, that do not exist together in nature. A "food" is a nutritious substance that animals, including humans, pets and livestock, ingest (e.g., eat or drink). A "nutritious substance" is a macronutrient such as a fat, carbohydrate or protein, or a micronutrient such as an essential or non-essential vitamin or mineral.

A sweetness enhancer comprising a Gly-Phe dipeptide may be incorporated into a food product containing a sweetener. In embodiments, the food product includes an additional ingredient (in addition to the sweetness enhancer and the sweetener). The additional ingredient may be a nutritious ingredient; that is, an ingredient that is a nutritious substance. The sweetness enhancer may be present in the food product in an amount effective to enhance the sweetness of the food product. In embodiments, one or more of the sweetness enhancer and the sweetener, and optionally the additional ingredient, are present in the food product in amounts or concentrations not found in naturally existing food products, such as bananas, peppers, avocados, wheat, or the like.

In embodiments, the food product comprises one or more sweetness enhancers comprising a Gly-Phe dipeptide in an amount or concentration effective to enhance the perception of sweetness of the food product. In embodiments, the one or more sweetness enhancers are present in the food product in an amount or concentration effective to enhance the perception of sweetness such that less sweetener may be included in the food product to elicit a similar perception of sweetness as a substantially similar food product that does not include the one or more sweetness enhancer.

In embodiments, the one or more sweetness enhancers comprising a Gly-Phe dipeptide are present in a food product in an amount or concentration effective to enhance the
perception of sweetness such that the amount of sweetener may be reduced by about 5% by weight or more, such as about 10% by weight or more, about 15% by weight or more, about 20% by weight or more, or about 25% by weight or more, per serving relative to a substantially similar food product that does not have the one or more sweetness enhancer while having a similar sweet taste.

In embodiments, the one or more sweetness enhancers comprising a Gly-Phe dipeptide are present in a food product in an amount or concentration effective to enhance the perception of sweetness such that the amount of labeled sugars in a serving of a food product may be reduced to about 10 grams or less, more particularly to about 8 grams or less, more particularly to about 6 grams or less, more particularly to about 5 grams or less, more particularly to about 3 grams or less. By way of example, it may be desirable to reduce sugars by about 2 grams or more in cereals or snacks per serving relative to a substantially similar food product that does not have the one or more sweetness enhancer comprising a Gly-Phe dipeptide while having a similar sweetness. It may be desirable to reduce sugars to about 10 grams or less, more particularly to about 8 grams or less, more particularly to about 6 grams or less, more particularly to about 5 grams or less, more particularly to about 3 grams or less in cereals or snacks per serving. For cereal, a typical serving size is 30 grams. Of course, cereals may have other serving sizes.

By way of further example, yogurt labeled sugar is typically about 27 grams per 6 ounce serving. In embodiments, a yogurt having a sweetness enhancer comprising a Gly-Phe dipeptide includes less than 27 grams of labeled sugars. For example, the yogurt could include about 22 grams, about 18 grams, about 15 grams, about 10 grams, or about 6 grams of labeled sugars. Preferably, the yogurt that includes a sweetness enhancer and reduced amounts of labeled sugars tastes as sweet as a yogurt that has a full amount of labeled sugar (e.g., 27 grams) but does not include the sweetness enhancer.

By way of further example, sweetened beverage labeled sugar is typically about 39 grams per 12 ounce serving. In embodiments, a sweetened beverage having a sweetness enhancer comprising a Gly-Phe dipeptide includes less than 39 grams of labeled sugars. For example, the sweetened beverage could include about 30 grams, about 20 grams, about 10 grams, or about 5 grams of labeled sugars. Preferably, the sweetened beverage that includes a sweetness enhancer and reduced amounts of labeled sugars tastes as sweet as a
beverage that has a full amount of labeled sugar (e.g., 39 grams) without the sweetness enhancer.

[0021] A food product or composition may include one or more sweetness enhancers described herein in any suitable concentration. By way of example, a sweetness enhancer comprising a Gly-Phe dipeptide described herein may be present in a food product at a concentration from about 0.0001% by weight to about 0.5% by weight. In embodiments, a sweetness enhancer comprising a Gly-Phe dipeptide is present in a food product at a concentration of about 0.2% by weight or less, such as about 0.1% by weight or less, about 0.05% by weight or less, about 0.02% by weight or less, or about 0.01% by weight or less. It will be understood that the concentration of the sweetness enhancer may be varied to minimize unpleasant or off flavor notes while achieving effective enhancement of sweetness. It will also be understood that the concentration of sweeteners in the food product may affect the desired concentration of a sweetness enhancer. For example, if more sweetener is present, less sweetness enhancer may be desired. In addition, it will be understood that the presence of more than one sweetness enhancer may affect the desired concentration of other sweetness enhancers, particularly if the effects of the sweetness enhancers are additive or synergistic.

[0022] Any one or more sweeteners may be present or incorporated into a food product that contains a sweetness enhancer. A "sweetener" is a compound that elicits a sweet taste. Examples of sweeteners include abiziasaponin, abrusosides, in particular abrusoside A, abrusoside B, abrusoside C, abrusoside D, acesulfame potassium, advantame, albiziasaponin, alitame, aspartame, superaspartame, bayunosides, in particular bayunoside 1, bayunoside 2, brazzein, bryoside, bryonoside, bryonoduloside, carnosifloside, carrelame, curculin, cyanin, chlorogenic acid, cyclamates and its salts, cyclocaryoside 1, dihydroquercetin-3-acetate, dihydroflavenol, dulcoside, gaudichaudioside, glycyrrhizin, glycyrrhetin acid, gypenoside, hematoxylin, isomogrosides, in particular iso-mogroside V, lugduname, magap, mabinlinns, micraculin, mogrosides (lo han guo), in particular mogroside IV and mogroside V, monatin and its derivatives, monellin, mukurozioside, naringin dihydrochalcone (NarDHC), neohesperidin dihydrochalcone (NDHC), neotame, osladin, pentadin, perianadrin I-V, perillartine, D-phenylalanine, phlomisosides, in particular phlomisoside 1, phlomisoside 2, phlomisoside 3, phlomisoside 4, phloridzin, phyllodulcin, polpodiosides, polyposide A, pterocaryosides, rebaudiosides, in particular

tryptophane, erythritol, galactitol, hydrogenated starch syrups including maltitol and sorbitol syrups, inositol, isomalt, lactitol, maltitol, mannitol, xylitol, arabinose, dextrin, dextrose, fructose, high fructose corn syrup, fructooligosaccharides, fructooligosaccharide syrups, galactose, galactooligosaccharides, glucose, glucose and (hydrogenated) starch syrups/hydrolysates, isomaltulose, lactose, hydrolysed lactose, maltose, mannose, rhamnose, ribose, sucrose, tagatose, trehalose and xylose. Some sweeteners are described, for example, by H. Mitchell (H. Mitchell, "Sweeteners and Sugar Alternatives in Food Technology", Backwell Publishing Ltd, 2006) and in WO 2009/023975 A2, each of which is hereby incorporated herein by reference in its entirety to the extent that it does not conflict with the present disclosure.

[0023] In embodiments, a food product includes at least one sugar sweetener. Examples of sugar sweeteners include monosaccharides, disaccharides, oligosaccharides and polysaccharides. Such sugar sweeteners include dextrin, dextrose, fructose, high fructose corn syrup, fructooligosaccharides, fructooligosaccharide syrups, galactose, galactooligosaccharides, glucose, glucose and (hydrogenated) starch syrups/hydrolysates, isomaltulose, lactose, hydrolysed lactose, maltose, mannose, rhamnose, ribose, sucrose, tagatose, trehalose, and xylose.

[0024] In embodiments, a food product includes one or more of at least one disaccharide and fructose as a sweetener. Examples of disaccharides include isomaltulose, lactose, maltose, sucrose, and trehalose.

[0025] In embodiments, a food product includes at least one sugar alcohol (or polyol) as a sweetener. Examples of sugar alcohols or polyols include erythritol, galactitol, hydrogenated starch syrups including maltitol and sorbitol syrups, inositol, isomalt, lactitol, maltitol, mannitol, and xylitol.
In embodiments, a food product includes one or more of sucrose, glucose or fructose as a sweetener. One or more of sucrose, fructose or glucose may be present in the food product at any suitable amount or concentration. In embodiments, the total amount of sucrose, glucose and fructose present in the food product is an amount up to about 30 weight percent, more particularly, up to about 10 weight percent, even more particularly up to about 2 weight percent, or in the range of about 2 to about 30 weight percent, or about 5 to about 25 weight percent, or about 10 to about 20 weight percent. In embodiments, a food product that includes one or more sweetness enhancer comprises no more than 2 weight percent, no more than 10 weight percent sugars, or no more than 30 weight percent of cumulative sucrose, glucose and fructose. It will be understood that a desired weight percent of sucrose, glucose and fructose may vary depending on the type of food product. For example, it may be desirable for a table-top sweetener food product to have a higher weight percent of sucrose, glucose or fructose than a beverage or a breakfast cereal. In embodiments, a food product that includes one or more sweetness enhancer comprises no more than 2 cumulative grams of sucrose, glucose and fructose sugars per serving, no more than 10 cumulative grams of sucrose, glucose and fructose per serving, or no more than 30 cumulative grams of sucrose, glucose and fructose per serving.

One or more sweetness enhancer may be utilized in connection with virtually any food product for which it is desired to enhance the perception of a sweet taste or other taste associated with consumption of a sweetener. The sweetness enhancers can find application for imparting sweetness to beverages or food dishes or as an ingredient in snack foods or other food products in which sweetness is desired.

Examples of food products that may incorporate one or more sweetness enhancers include a confectionary, a gum, a bakery product, an ice cream, a dairy product, a fruit snack, a chip or crisp, an extruded snack, a tortilla chip or corn chip, a popcorn, a pretzel, a nut, a snack bar, a meal replacement, a ready meal, a soup, a pasta, a canned food, a frozen processed food, a dried processed food, an instant noodle, a chilled processed food, an oil or fat, a sauce dressing or condiment, a dip, a pickled product, a seasoning, a baby food, a spread, a chip or a crisp such as chips or crisps comprising potato, corn, rice, vegetable (including raw, pickled, cooked and dried vegetables), a fruit, a grain, a soup, a seasoning, a baked product such as a ready-to-eat breakfast cereal, hot cereal or dough, an ice cream such as a frozen yogurt, a dairy products such as a yogurt or cheese, ready meal, a soup, a
pasta, a canned food, a frozen processed food, a dried processed food, an instant noodle, or a chilled processed food, a beverage including beverages that include fiber or protein a meat or a meat substitute, a pet food, an animal product, a medical food, a nutritional supplement, a vitamin supplement, and an infant formula product.

In embodiments, one or more sweetness enhancers are incorporated into a medicinal or pharmaceutical product, or the like.

In embodiments, a food product is a processed food product. Food processing includes the transformation of raw ingredients into food or transforming forms of food into other forms of food. Food processing often includes using harvested crops or animal products to produce marketable products sold to consumers at stores, restaurants and the like. Processed food products include products for which additional processing by a consumer occurs after purchase but prior to consumption (e.g., heating, cooking, baking, or the like).

Particularly suitable food products including soup, meal kits, grain products such as ready-to-eat cereals, snacks, bars and baked dough, and dairy products such as ice cream, yogurt and cheese. In some aspects, a sweetness enhancer is used to reduce the amount of sweetener that is typically included in soups, including (but not limited to) chicken or poultry broth, chicken- or poultry-based soups (such as chicken noodle soup), tomato-based soups, and the like. In some aspects, a sweetness enhancer is used to reduce sweetener in meal kits, such as kits that include ingredients to be combined with meat to prepare a meal. Such meal kits can include dried components (such as noodles, rice, dried potatoes, or the like) and seasoning packages. In some aspects, a sweetness enhancer is used to reduce sweetener that is typically added to a snack food to enhance its flavor. Exemplary snack foods include potato chips, corn chips, pretzels, fruit-type snacks, and snack mixes including any mixes of any of these foods with other ingredients (such as cereals).

In some aspects, sweetness enhancer is used to reduce the amount of sweetener that is typically included in a ready-to-eat cereal or other grain-based food products, such as dough, baked goods, grain snacks, grain bars, or the like. In some aspects, a sweetness enhancer is used to reduce the amount of sweetener that is typically included in dairy-based food products, such as fresh or frozen dairy products, which may include yogurt, ice cream, or the like. In some aspects, a sweetness enhancer is used to reduce the amount of
sweetener that is typically included in packaged meal food products, such as packaged meals that contain rice, potatoes, or vegetables, dry packaged meals, frozen packaged meals, or the like.

[0033] For the purposes of the present disclosure "grain" includes grain and pseudograin. Examples of food grains include corn; sorghum; fonio; millet such as pearl millet, proso millet, finger millet, foxtail millet, Japanese millet, kodo millet and the like; Job's tears; wheat; rice; rye; barley; oat; triticale; wild rice; teff; amaranth; quinoa; buckwheat; and the like.

[0034] A sweetness enhancer can also be used in connection with soup, broth, sauce (such as basting sauce), various seasoning sauces, ketchup, dressings, and other like foods.

[0035] In embodiments, a food product into which a sweetness enhancer is included has a water content of about 30% or more by weight. For example, the food product may have a water content of about 35% or more, or about 40% or more by weight. Non-limiting examples of food products that typically have water contents of about 30% or more by weight include soups, beverages, batters and dough.

[0036] In embodiments, a food product into which a sweetness enhancer is included has a water content of about 50% or more by weight. For example, the food product may have a water content of about 60% or more, or about 70% or more by weight. Non-limiting examples of food products that typically have water contents of about 50% or more by weight include soups and beverages.

[0037] In embodiments, a food product into which a sweetness enhancer is included has a water content of about 20% or less by weight. For example, the sweetness enhancer may be incorporated into dry food products that having low water contents. In embodiments, a sweetness enhancer is included in a dried form, such as a table-top sweetener. In embodiments, the dried sweetener comprises, consists essentially of, or consists of one or more sweetness enhancers, one or more optional carriers, and one or more sweeteners.

[0038] In embodiments, a sweetness enhancer comprising a Gly-Phe dipeptide described herein can be substituted for, or used in addition to, other known sweetness enhancers, such as those described in, for example, EP 2606747 A1, entitled "Sweetness enhancer, sweetener
compositions and consumables containing the same;" WO 2013/143822 Al, entitled "Adenosine as sweetness enhancer for certain sugars;" and WO 2007/014879 Al, entitled "Use of hesperetin for enhancing the sweet taste," each of which is hereby incorporated herein by reference to the extent that they do not conflict with the present disclosure.

In embodiments, a method includes setting a target sweet taste of a food product, including an amount of a sweetener that imparts a sweet taste in the food product, where the amount of the sweetener does not achieve the target level of sweet taste, and including an amount of a sweetness enhancer described herein (or more than one sweetness enhancer) to achieve the desired sweet taste. In embodiments, a method includes setting a target sweet taste of a food product, including an amount of a high caloric sweetener in the food product that does not achieve the target level of sweet taste, including an amount of a no- or low-caloric sweetener and an amount of a sweetness enhancer described herein (or more than one sweetness enhancer) to achieve the desired sweet taste.

PROCESSING

A sweetness enhancer comprising Gly-Phe described herein can be added to food products in dry or liquid form. For example, a taste modulating or sweet taste modulating compound that is in the liquid form can be prepared by dissolving or suspending the compound in an appropriate relative amount in a liquid. Useful liquids include water, alcohol-water mixtures, triacetin, propylene glycol, and triglycerides and other known organic solvents. Depending upon the concentration of the sweetness enhancer, it can be desirable to heat the mixture to dissolve the compound.

Sweetness enhancers that exist in a dry state, such as powders or granules, can be prepared by either mixing or blending the compounds with other components in the dry state. The dry blending or mixing can be carried out in any conventional suitable apparatus. In some aspects, the sweetness enhancers described herein can be prepared into dry compositions by commonly used methods of granulation from mixtures of the several ingredients. Such starting mixtures can be wetted in known manner, granulated, and their granulations dried as usual and screened to give a product approximately the typical size of common granulated sugar (sucrose).
Sweetness enhancers that exist in a dry composition state can be alternatively prepared by first forming a solution, emulsion or suspension of the compounds and other individual components, and then extruding or drying the solution or suspension. The thus-prepared solution, emulsion or suspension can then be dried using any conventional suitable apparatus, such as a rotary drier, a drum drier, or a fluidized bed drier or spray drier.

Sweetness enhancers described herein can be prepared by thoroughly mixing the compounds with other components in the indicated proportions until a suitably mixed (for example, homogeneous) product is attained.

Compositions or formulations containing the sweetness enhancers can then be combined with a food product.

PERCEPTION OF SWEETNESS

In embodiments, a composition that includes a sweetness enhancer comprising Gly-Phe is perceived as imparting a quantity of sweetness equal to a substantially similar composition that does not include the sweetness enhancer but that has a higher concentration of the sweetener. Preferably, the composition that includes the sweetness enhancer imparts a perception of sweetness equal to the substantially similar composition that does not have the sweetness enhancer when the composition has less sweetener than the substantially similar composition (e.g., sweetener reduced by about 1% or more). For example, the composition that includes the sweetness enhancer may impart a perception of sweetness equal to the substantially similar composition that does not have the sweetness enhancer when the composition that includes the sweetness enhancer has a sweetener concentration reduced by about 2% or more, about 5% or more, about 7% or more, about 8% or more, about 9% or more, about 10% or more, about 11% or more, about 15% or more, about 20% or more, about 30% or more, about 35% or more, about 40% or more, or about 50% or more, relative to the substantially similar composition. In embodiments, one or more sweetness enhancers may be present in a food product in an amount sufficient to reduce the amount of a sweetener by about 1% or more, about 2% or more, about 5% or more, about 7%, or more, about 8% or more, about 10% or more, about 11% or more, about 12% or more, about 15% or more, about 20% or more, about 22% or more, about 25% or more, about 30%, or more, about 35% or more, about 40% or more, about 45% or more, about 50% or more, about 55% or more, about 60% or more, about 65% or more, about 70% or
more, about 75% or more, about 80% or more, about 85% or more, about 90% or more, about 95% or more, or the like. Preferably, the reduced sweetener food product elicits the same or similar perception of sweetness as a substantially similar food product that does not include the one or more sweetness enhancers.

[0048] Perception of sweetness may be evaluated in any suitable manner. In embodiments, sweetness is determined by a trained analytical sensory panel. In embodiments, the trained sensory panel determines the sweetness of a composition having a sweetness enhancer and a sweetener relative to a substantially similar composition having increased sweetener content.

[0049] A food product that elicits a "similar" perception of sweetness to another food product (i.e., a substantially similar food product) is a food product that a panel of trained sensory evaluators, on average, will determine to have a sweetness within a range of 80% to 120% of the sweetness of the second food product.

[0050] Sensory panelists may be trained in any suitable manner. Preferably, the panelists are trained to discern sweetness or other attributes without reference to liking or acceptability. The panelists are also preferably trained to accurately quantify sweet taste or other attributes according to an intensity scale. General information that may be helpful in understanding beneficial training protocols can be found in, for example, Sensory Evaluation Techniques, 4th Ed by Meilgaard M., Civille G.V. and Carr B.T (2007), CRC Press, pages 147-152. Prescreening, selection, and training of panelists may occur as described in one or more standards, such as Hootman RC, Manual 13 MNL13 Manual on Descriptive Analysis Testing for Sensory Evaluation, ASTM (1992); STP758 Guidelines for the Selection and Training of Sensory Panel Members, ASTM (1981); and Munoz A.M and Civille, G.V., MLN13: The Spectrum Descriptive Analysis Method, ASTM (1992). Preferably panelists are trained according to the Spectrum Method (Munoz A.M and Civille, G.V., MLN13: The Spectrum Descriptive Analysis Method, ASTM 1992).

[0051] Preferably, average scores regarding sweetness from more than one panelist trained to discern sweet taste or other attributes using the same training are considered in determining whether a reduced sweetener food product elicits the same or similar perception of sweetness as a substantially similar food product that does not include a sweetness enhancer comprising Gly-Phe. For example, a panel may contain three or more
trained panelists, 5 or more trained panelists, 7 or more trained panelists, 10 or more trained panelists, or the like.

[0052] One preferred method of determining effectiveness of sweetness enhancers is described in more detail in the Examples that follow in which trained sensory panelists rest and thoroughly rinse their mouths between tastings of compositions that may or may not contain a sweetness enhancer.

[0053] SWEETNESS ENHANCERS COMPRISING GLY-PHE

[0054] A variety of naturally-derived compounds were tested in animal studies to evaluate sweetness or sweetness enhancement of the compounds. In total 96 compounds were tested. Of the compounds tested, only the dipeptide Gly-Phe was identified as a sweetness enhancer.

[0055] However, it is believed that compounds comprising a Gly-Phe dipeptide may also exhibit sweetness enhancing effects. Any sweetness enhancer comprising a Gly-Phe dipeptide may be employed in accordance with the teachings presented herein.

[0056] In embodiments, the sweetness enhancer consists of a Gly-Phe dipeptide or a physiologically acceptable salt, polymorph, hydrate thereof or a sweet enhancing isomer thereof. As described in the Examples that follow, Gly-Phe dipeptide has been determined to effectively enhance sweetness of sucrose by from about 5% to about 26%. At effective sweetness enhancing concentrations, Gly-Phe was clean-tasting (i.e., it was observed by trained tasters to have little or no unpleasant or off flavor notes or after-taste). Gly-Phe was an effective sweetness enhancer at concentrations of 100 parts per million (0.01% by weight). However, at 100 ppm Gly-Phe was as effective a sweetness enhancer as at 200 ppm. Accordingly, it is believed that Gly-Phe may be an effective sweetness enhancer at concentrations lower than 100 ppm (0.01% by weight).

[0057] In embodiments, a Gly-Phe dipeptide has the following structural formula:
In embodiments, a sweetness enhancer comprising Gly-Phe is a derivative of a compound for Formula I. By way of example, substitutions at the terminal amine, the alpha carbon, the internal amine, the carboxylic acid, the phenyl group, or the like may result in a sweetness enhancing compound. In some embodiments, such sweetness enhancing derivatives of a compound of Formula I may result in compounds that do not impart a sweet taste in the absence of a sweetener, particularly in amounts that they may be employed in a food product. In some embodiments, such sweetness enhancers may impart a sweet taste on their own. However, in such embodiments, the sweetness enhancers preferably act synergistically with a sweetener to result in a perception of sweetness greater than the expected additive effects of the sweetener alone and the sweetness enhancer alone.

Preferably, a sweetness enhancer comprising Gly-Phe is a naturally-derived compound or a compound synthesized to have a structure of a naturally-derived compound.

In embodiments, a sweetness enhancer comprising Gly-Phe is a compound that is a naturally-occurring derivative of a Gly-Phe dipeptide. For example, the sweetness enhancer comprising Gly-Phe may be amidated, glycosylated, phosphorylated, or the like.

In embodiments, a sweetness enhancer comprising Gly-Phe is a polypeptide having three or more amino acids, provided that two of the amino acids are Gly-Phe. The Gly-Phe dipeptide may be on the N-terminus of the polypeptide (e.g., the Gly being the N-terminal amino acid), on the C-terminus (e.g., Phe being the C-terminal amino acid), or between the N-terminus and C-terminus.
By way of example, the following three scenarios are tetrapeptides that may comprise a Gly-Phe dipeptide: X-Y-Gly-Phe, where X and Y are independently any amino acid; Gly-Phe-X-Y, where X and Y are independently any amino acid; and X-Gly-Phe-Y, where X and Y are independently Gly-Phe.

A sweetness enhancer comprising Gly-Phe may directly act to enhance the perception of sweet taste of a sweetener or may be converted, when ingested, into a compound that directly acts to enhance the perception of sweet taste of the sweetener.

Gly-Phe dipeptides or polypeptides comprising Gly-Phe may be synthesized or produced in any suitable manner, such as protein hydrolysis, chemical synthesis (e.g., Merrifield solid phase synthesis), enzymatic synthesis, over expression in yeast or bacteria, or the like. Gly-Phe is commercially available from Sigma-Aldrich or may be synthesized by methods such as R.B. Merrifield, J. Am. Chem. Soc. 85(14):2149-2154.

SCREENING COMPOUNDS FOR SWEETNESS ENHANCEMENT

Sweetness enhancing properties of a compound, in some embodiments, can be identified by an in vitro in cell based assay as described in the Examples, in US Patent No. 7,244,835, EP 1 865 316 B1, or by field effector transistor technology of e.g. Alpha MOS.

Animals, such as rats, may be trained to discriminate sweet taste from water and to discern varying levels of sweetness. One suitable animal-based assay is a MOG (microtiter operant gustometer) assay. See, R.K. Palmer et. al, Appetite (2008), vol. 51, no. 2, 389.

Of course any other suitable screening assay may be employed to determine if a compound exhibits sweetness enhancing properties. Preferably, sweetness enhancement is confirmed by a trained sensory panel (e.g., as described above).

DEFINITIONS

All scientific and technical terms used herein have meanings commonly used in the art unless otherwise specified. The definitions provided herein are to facilitate understanding of certain terms used frequently herein and are not meant to limit the scope of the present disclosure.
As used in this specification and the appended claims, the singular forms "a", "an", and "the" encompass embodiments having plural referents, unless the content clearly dictates otherwise.

As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise. The term "and/or" means one or all of the listed elements or a combination of any two or more of the listed elements.

As used herein, "have", "having", "include", "including", "comprise", "comprising" or the like are used in their open ended sense, and generally mean "including, but not limited to". It will be understood that "consisting essentially of", "consisting of", and the like are subsumed in "comprising" and the like. As used herein, "consisting essentially of," as it relates to an composition, product, method or the like, means that the components of the composition, product, method or the like are limited to the enumerated components and any other components that do not materially affect the basic and novel characteristic(s) of the composition, product, method or the like.

The words "preferred" and "preferably" refer to embodiments of the invention that may afford certain benefits, under certain circumstances. However, other embodiments may also be preferred, under the same or other circumstances. Furthermore, the recitation of one or more preferred embodiments does not imply that other embodiments are not useful, and is not intended to exclude other embodiments from the scope of the disclosure, including the claims.

Also herein, the recitations of numerical ranges by endpoints include all numbers subsumed within that range (e.g., 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, 5, etc. or 10 or less includes 10, 9.4, 7.6, 5, 4.3, 2.9, 1.62, 0.3, etc.). Where a range of values is "up to" a particular value, that value is included within the range.

As used herein, the term "about" encompasses the range of experimental error that occurs in any measurement.

As used herein, a compound "derived" from a natural product is a compound that exists in a natural product, whose identity is verified. The compound derived from the natural
product may be extracted from, for example, a plant or microbial source as opposed to being produced synthetically. Extraction or isolation of the naturally-derived compound may be facilitated by simple chemical reactions such as acidification, basification, ion exchange, hydrolysis, and salt formation as well as microbial fermentation, and the like. In embodiments, a sweetness enhancer comprising Gly-Phe is derived from natural sources such as natural plant, fungi, and bacterial sources.

[0078] As used herein, an "isolated" or "purified" compound is a compound that is substantially separated from other components of the source of the compound. For example, if the source of the compound is a natural product, an isolated or purified compound may be a compound that is separated from its naturally occurring environment. If the compound is synthesized, the compound may be separated from unreacted reagents, reaction byproducts, solvents, or the like.

[0079] As used herein a "synthetic compound" is a compound that is synthesized via chemical reaction in vitro. A compound that is "synthesized" is a synthetic compound. A synthesized compound may be identical to a compound derived from a natural product.

[0080] For the purposes of this disclosure, reference to a compound includes reference to salts of the compound, hydrates of the compound, polymorphs of the compound, isomers of the compound (including constitutional isomers and stereoisomers such as enantiomers and diasteriomers), and the like.

[0081] INCORPORATION BY REFERENCE

[0082] Any patent or non-patent literature cited herein is hereby incorporated herein by reference in its entirety to the extent that it does not conflict with the disclosure presented herein.

[0083] In the detailed description above several specific embodiments of compounds, compositions, products and methods are disclosed. It is to be understood that other embodiments are contemplated and may be made without departing from the scope or spirit of the present disclosure. The detailed description, therefore, is not to be taken in a limiting sense.

[0084] In the following non-limiting examples that provide illustrative embodiments of the compositions, food products, methods and sweetness enhancers described above. These
examples are not intended to provide any limitation on the scope of the disclosure presented herein.

EXAMPLES

[0085] The inventors set out to identify compounds that are considered to be generally regarded as safe (according to the U.S. Food and Drug Administration) and that are sweeteners or sweetness enhancers.

[0086] Structural modeling based on the structures of known sweeteners and sweetness enhancers was performed. Libraries were then searched to identify naturally-derived compounds that fit the modeling. The identified naturally-derived compounds were then screened in animal assays to provide an initial assessment as to whether the compounds may impart or enhance a sweet taste.

[0087] Briefly, rats were trained to discriminate sweet (sucrose) taste from water, salt (NaCl), acid (citric acid), and bitter (quinine) by using a food reward system. Rats were then presented small amounts of sample compounds, one well at a time, from a 96-well microtiter plate. Sucrose standard concentrations were included as positive controls, and test compounds were presented to the rats with and without sucrose present to determine whether compounds had any inherent sweet taste and to determine the level of enhancement compared to comparable sucrose standards.

[0088] In total, 96 compounds were identified and screened. None of the identified compounds were determined to be candidates for use as sweeteners. Only the dipeptide Gly-Phe was determined to be a candidate for use as a sweetness enhancer.

[0089] Trained sensory panelists then determined the effectiveness of Gly-Phe as a sweetness enhancer. Two studies were performed.

[0090] In one study, nine panelists reviewed a series of sweet references (2.0, 5.0, 7.5, 10.0, and 12.5; corresponding to weight percent sucrose in water). Between samples the panelists rinsed their mouth and spit five times, wiped their lips, and waited two minutes before tasting another sample. All solutions were served in 2 ounce cups and prepared with
bottled water (same source for all testing), which was also used for the 0.0 reference and for rinsing. Panelists used samples 01, 0.3 and 0.6 for orientation (the content of the samples is presented below in Table 1). The samples were served in randomized order. White lights were used. Gly-Phe was purchased from Sigma-Aldrich. Sucrose was obtained from American Sugar Refining Inc.

### Table 1: Sample Description

<table>
<thead>
<tr>
<th>Sample</th>
<th>REP 1 Code</th>
<th>REP 2 Code</th>
<th>Sample ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>737</td>
<td>572</td>
<td>Gly-Phe at 200 ppm in water</td>
</tr>
<tr>
<td>02</td>
<td>263</td>
<td>348</td>
<td>Gly-Phe at 200 ppm in 2.5% sucrose</td>
</tr>
<tr>
<td>03</td>
<td>662</td>
<td>762</td>
<td>Gly-Phe at 200 ppm in 5% sucrose</td>
</tr>
<tr>
<td>04</td>
<td>787</td>
<td>617</td>
<td>Gly-Phe at 750 ppm in water</td>
</tr>
<tr>
<td>05</td>
<td>434</td>
<td>872</td>
<td>Gly-Phe at 750 ppm in 2.5% sucrose</td>
</tr>
<tr>
<td>06</td>
<td>535</td>
<td>995</td>
<td>Gly-Phe at 750 ppm in 5% sucrose</td>
</tr>
</tbody>
</table>

[0091] The panelists immediately rated each sample for the following tastes: Sweet, Salt, Sour, and Bitter. The panelists also rated the overall aromatics and identified any aromatics present.

[0092] In general, the panelists determined that Gly-Phe, at the concentrations used, was a clean-tasting compound that demonstrated sweetness enhancement but did not taste sweet on its own.

[0093] A summary of the results are presented in Table 2 below and in FIG. 1. As shown in FIG. 1, Gly-Phe demonstrated sweetness enhancement of 18%–26% when added to 2.5% and 5.0% sucrose. The sweetness enhancement effect of Gly-Phe was essentially the same at 200 ppm as at 750 ppm, indicating that lower concentrations of Gly-Phe may also be effective.

[0094] As shown in Table 2 below, Gly-Phe had little or no additional tastes, with no aromatics that reached a threshold level of 0.5 units. Only a minority of panelist even detected aromatics in the samples.
Table 2: Table of means with Tukey Multiple Means Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Gly-Phe at 200 ppm in water</th>
<th>Gly-Phe at 200 ppm in 2.5% sucrose</th>
<th>Gly-Phe at 700 ppm in 5% sucrose</th>
<th>Gly-Phe at 750 ppm in 2.5% sucrose</th>
<th>Gly-Phe at 750 ppm in 5% sucrose</th>
<th>Prob(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet</td>
<td>0.0 a</td>
<td>3.4 b</td>
<td>6.3 c</td>
<td>0.0 a</td>
<td>3.3 b</td>
<td>6.1 c</td>
</tr>
<tr>
<td>Sour</td>
<td>0.1 a</td>
<td>0.1 a</td>
<td>0.2 a</td>
<td>0.2 a</td>
<td>0.1 a</td>
<td>0.1 a</td>
</tr>
<tr>
<td>Bitter</td>
<td>0.1 a</td>
<td>0.0 a</td>
<td>0.1 a</td>
<td>0.3 a</td>
<td>0.1 a</td>
<td>0.1 a</td>
</tr>
<tr>
<td>Aromatic</td>
<td>0.1 a</td>
<td>0.1 a</td>
<td>0.1 a</td>
<td>0.3 a</td>
<td>0.1 a</td>
<td>0.1 a</td>
</tr>
<tr>
<td>Aromatics Detected</td>
<td>Astringent, Floral, Waxy</td>
<td>Citrus (Dreamsicle), Floral</td>
<td>Orange, Waxy, Astringent</td>
<td>Orange, Floral, Astringent, Waxy</td>
<td>Citrus, Waxy, Astringent</td>
<td>Waxy</td>
</tr>
</tbody>
</table>

Means sharing the same letter are not significantly different at the 95% confidence level.

[0095] In the other study, ten panelists reviewed a series of sweet references (2.0, 5.0, 7.5, 10.0, and 12.5, corresponding to weight percent sucrose in water). Between samples the panelists rinsed their mouth and spit five times, wiped their lips, and waited two minutes before tasting another sample. All solutions were served in 2 ounce cups and prepared with bottled water (same source for all testing). The samples (the content of the samples is presented below in Table 3) were served in randomized order, with the panelists being blinded with regard to the sucrose samples. White lights were used. Gly-Phe was purchased from Sigma-Aldrich. Sucrose was obtained from American Sugar Refining, Inc.

Table 3: Sample Description

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>2.5% Sucrose</td>
</tr>
<tr>
<td>02</td>
<td>Gly-Phe at 100 ppm in 2.5% sucrose</td>
</tr>
<tr>
<td>03</td>
<td>Gly-Phe at 200 ppm in 2.5% sucrose</td>
</tr>
<tr>
<td>04</td>
<td>5.0% sucrose</td>
</tr>
<tr>
<td>05</td>
<td>Gly-Phe at 100 ppm in 5.0% sucrose</td>
</tr>
<tr>
<td>06</td>
<td>Gly-Phe at 200 ppm in 5.0% sucrose</td>
</tr>
</tbody>
</table>
The panelists immediately rated each sample for the following tastes: Sweet, Salt, Sour, and Bitter. The panelists also rated the overall aromatics and identified any aromatics present.

In general, the panelists determined that Gly-Phe, at the concentrations used, was a clean-tasting compound that demonstrated sweetness enhancement but did not taste sweet on its own. However, when compared to blind sucrose standards, the degree of enhancement was reduced compared to the study presented above.

A summary of the results are presented in Tables 4 below in FIG. 2. As shown in FIG. 2, Gly-Phe demonstrated sweetness enhancement of 3%-15% when added to 2.5% and 5.0% sucrose. Both 100 ppm Gly-Phe and 200 ppm Gly-Phe resulted in similar levels of enhancement, indicating that concentrations of Gly-Phe lower than 100 ppm may also enhance sweetness.

As shown in Table 4 below, Gly-Phe had little or no additional tastes or aromatics.

Table 4: One-Way Table of Means - Overall

<table>
<thead>
<tr>
<th></th>
<th>2.5% Sucrose</th>
<th>Gly-Phe at 100 ppm in 2.5% sucrose</th>
<th>Gly-Phe at 200 ppm in 2.5% sucrose</th>
<th>5.0% Sucrose</th>
<th>Gly-Phe at 100 ppm in 5.0% sucrose</th>
<th>Gly-Phe at 200 ppm in 5.0% sucrose</th>
<th>Prob(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sweet</td>
<td>2.8 a</td>
<td>3.2 a</td>
<td>3.2 a</td>
<td>5.7 b</td>
<td>6.0 b</td>
<td>6.0 b</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Salt</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>1.0</td>
</tr>
<tr>
<td>Sour</td>
<td>0.1 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.1594</td>
</tr>
<tr>
<td>Bitter</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.1 a</td>
<td>0.1 a</td>
<td>0.0 a</td>
<td>0.0 a</td>
<td>0.3453</td>
</tr>
<tr>
<td>Other Aromatics</td>
<td>0 a</td>
<td>0 a</td>
<td>0 a</td>
<td>0 a</td>
<td>0 a</td>
<td>0 a</td>
<td>0.7634</td>
</tr>
</tbody>
</table>
CLAIMS

1. A food product comprising:
   at least one compound that imparts a sweet taste; and
   a sweetness enhancer comprising Gly-Phe.

2. A food product according to claim 1, further comprising at least one additional ingredient.

3. A food product according to claim 1 or claim 2, wherein the sweetness enhancer is present in the food product in an amount effective to enhance a perception of sweetness of the food product.

4. A food product according to any one of claims 1 to 3, wherein the sweetness enhancer is a polypeptide comprising Gly-Phe.

5. A food product according to any one of claims 1 to 3, wherein the sweetness enhancer consists of Gly-Phe.

6. A food product according to any one of the preceding claims, wherein the food product comprises about 0.1 wt% or less of the sweetness enhancer.

7. A food product according to any one of claims 1 to 5, wherein the food product comprises about 0.05 wt% or less of the sweetness enhancer.
8. A food product according to any one of claims 1 to 5, wherein the food product comprises about 0.02 wt% or less of the sweetness enhancer.

9. A food product according to any one of claims 1 to 5, wherein the food product comprises about 0.01 wt% or less of the sweetness enhancer.

10. A food product according to any one of the preceding claims, wherein the sweetness enhancer does not impart a sweet taste in the absence of the compound that imparts the sweet taste.

11. A food product according to any one of the preceding claims, wherein the sweetness enhancer is present in the food product in an amount such that the sweetness enhancer does not impart a sweet taste in the absence of the compound that imparts the sweet taste.

12. A food product according to any one of the preceding claims, wherein the at least one compound that imparts sweet taste comprises sucrose.

13. A food product according to any one of the preceding claims, wherein the at least one compound that imparts a sweet taste comprises fructose.

14. A food product according to claim 13, wherein the food product comprises corn syrup as the source of the fructose.

15. A food product according to any one of the preceding claims, wherein the food product is ready to eat breakfast cereal.
16. A food product according to any one of claims 1-14, wherein the food product is yogurt.

17. A food product according to any one of claims 1-14, wherein the food product is a beverage.
Gly-Phe Sweet Taste Enhancement

↑ = enhancement of sweet taste beyond inherent sweetness of compound*
↓ = suppression of sweet taste below inherent sweetness of compound

* Note that Gly-Phe did not shown any inherent sweetness

FIG. 1
**Gly-Phe Sweet Taste Enhancement**

↑ = enhancement of sweet taste beyond inherent sweetness of compound
↓ = suppression of sweet taste below inherent sweetness of compound

*Sucrose ratings based on blind samples of 2.5% and 5.0% sucrose

FIG. 2
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23L1/22 A23L1/236
ADD.

According to International Patent Classification (IPC) and to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A23L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic database consulted during the international search (name of database and, where practicable, search terms used)
EPO-Internal, WPI Data, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents:
- "A": document defining the general state of the art which is not considered to be of particular relevance
- "E": earlier application or patent but published on or after the international filing date
- "L": document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O": document referring to an oral disclosure, use, exhibition or other means
- "P": document published prior to the international filing date but later than the priority date claimed
- "I": later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X": document of particular relevance: the claimed invention cannot be considered to be novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y": document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "S": document member of the same patent family

Date of the actual completion of the international search: 19 January 2015

Date of mailing of the international search report: 09/03/2015

Name and mailing address of the ISA:
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016

Authorized officer:
Saunders, Thomas

Form PCT/ISA/210 (second sheet) (April 2005)
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