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(54) Title: METHOD OF CONTROLLING RELEASE OF SWEETNESS ENHANCER IN CHEWING GUM AND GUM PRODUCED THEREBY

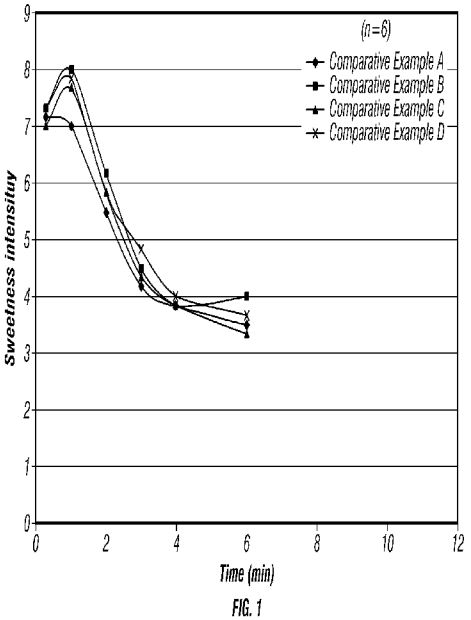

FIG. 1

(57) Abstract: A chewing gum composition includes a gum base and a water soluble bulk portion comprising i) one or more T1 R2 sweeteners encapsulated with a first encapsulating material and ii) a sweetness enhancer encapsulated with a second encapsulating material, the sweetness enhancer being selected from the group consisting of 4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1 H)-one and salts, solvates, and esters thereof.

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BACKGROUND OF THE INVENTION

[0001] The present invention relates to chewing gum and methods for producing chewing gum. More particularly the invention relates to producing chewing gum containing sucralose or other similar sweeteners and a sweetness enhancer wherein the sweetness enhancer is treated to control its release to provide an effective sweetness enhancement.

[0002] Chewing gum is frequently sweetened with high intensity sweeteners to reduce the caloric content of the gum. One commonly used high-intensity sweetener is sucralose (1,6-dichloro-1,6-dideoxy-.beta.-D-fructofuranosyl-4-chloro-4-deoxy -.alpha.-D-galacto-pyranoside).

[0003] One concern with using sucralose in chewing gum is the cost of the sucralose. There are known sweetness enhancers that can be added to products to modify the taste perception of an individual, and thus increase the perceived sweetness of a lesser quantity of sucralose in the product. Some suggestion has been made that such sweetness enhancers can be used in chewing gum. However, it was surprisingly discovered, as detailed below, that the known sweetness enhancer did not produce its intended effect when used in chewing gum sweetened with sucralose. Therefore a need exists for finding a way in which to use a sweetness enhancer in an effective method where the sucralose is used to sweeten chewing gum.

[0004] Other sweeteners, referred to along with sucralose herein as T1R2 sweeteners, are believed to have a similar chemosensory effect as sucralose, and the same need applies to those sweeteners.

SUMMARY OF INVENTION

[0005] The present invention includes a chewing gum composition and a method for producing chewing gum sweetened with one or more T1R2 sweeteners wherein a sweetness enhancer is treated in such a manner so as to make it effective in increasing the sweetness perception by an individual chewing the chewing gum. It was discovered that by treating the sweetness enhancer so as to modify its rate of release from chewing gum that the sweetness enhancer was effective to increase the perceived sweetness of the T1R2 sweetener in the chewing gum. Furthermore, treating the

sweetness enhancer so that the treated sweetness enhancer has the same or similar release properties and/or rates as the T1R2 sweetener provided increased perception of sweetness.

[0006] In a first aspect, an embodiment includes a chewing gum composition comprising a gum base and a water soluble bulk portion comprising i) one or more T1R2 sweeteners encapsulated with a first encapsulating material and ii) a sweetness enhancer encapsulated with a second encapsulating material, the sweetness enhancer being selected from the group consisting of 4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1H)-one and salts, solvates, and esters thereof.

[0007] In a second aspect, an embodiment includes a method of producing a chewing gum product containing a physically-modified sweetness enhancer in order to control the release rate of sweetness enhancer comprising the steps of a) mixing a quantity of a sweetness enhancer with an encapsulating agent in such a way as to encapsulate the sweetness enhancer in order to modify the rate of release of the sweetness enhancer in the chewing gum, the sweetness enhancer being selected from the group consisting of 4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1H)-one and salts, solvates, and esters thereof; and b) adding a quantity of the encapsulated sweetness enhancer and a quantity of one or more T1R2 sweeteners that is also encapsulated to a chewing gum formulation to provide a sweetness enhancer level in the chewing gum formulation of from about 0.0002% to about 0.2%.

[0008] In a third aspect, en embodiment includes a process for making chewing gum which comprises the steps of a) preparing a gum base; b) preparing a water soluble bulk portion; c) preparing a gradual release structure which comprises the steps of i) preparing a mixture of a sweetness enhancer and encapsulating material, having a ratio of sweetness enhancer to encapsulating material of between about 1:1800 and about 1:4, the sweetness enhancer being selected from the group consisting of 4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1H)-one and salts, solvates, and esters thereof; ii) extruding the mixture; and iii) grinding the extruded mixture into a gradual release structure; and, d) combining the gradual release structure, the gum base and the water soluble bulk portion, wherein the combination also includes an encapsulated T1R2 sweetener.

[0009] This sweetness enhancer, when modified according to the present invention, gives a chewing gum having a controlled-release sweetness enhancement, giving a highly consumer-acceptable chewing gum product.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] FIG. 1 is a graphical illustration comparing the sweetness intensity of chewing gum compositions made using a sucralose with some of the compositions including a sweetness enhancer that has not been treated.

[0011] FIG. 2 is a graphical illustration comparing the sweetness intensity of chewing gum compositions made using a sucralose with some of the compositions including a sweetness enhancer treated in accordance with example embodiments of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0012] The present invention will now be further described. In the following passages, different aspects of the invention are defined in more detail. Each aspect so defined may be combined with any other aspect or aspects unless clearly indicated to the contrary. In particular, any feature indicated as being preferred or advantageous may be combined with any other feature or features indicated as being preferred or advantageous.

[0013] Unless otherwise specified, all percentages herein are weight percentages. Several terms used in the specification and claims have a meaning defined as follows.

[0014] The term “chewing gum” includes bubble gum and all other forms of chewing gum.

[0015] The term “T1R2 sweetener” means sweeteners that are effective by interacting with the T1R2 Venus fly trap domain chemosensory receptor, as described in U.S. Patent No. 7,928,111. Sucralose, sucrose, fructose, glucose, aspartame, and neotame are all examples of T1R2 sweeteners.

[0016] When a quantity of sweetness enhancer is referenced herein and in the claims, the reference is to the amount of active sweetness enhancer, and does not include any carrier that may be included with the sweetness enhancer in a commercially available source.

[0017] As described in more detail below, chewing gum compositions contain a gum base (which may be a combination of different gum base formulations); and a water soluble bulk portion. In the case of the present invention, the water soluble bulk portion will include one or more T1R2 sweeteners and a sweetness enhancer treated to as to modify its release rate from the chewing gum composition. Depending on the particular sweetness release profile and shelf-stability needed, the one or more T1R2 sweeteners

may be encapsulated or non-encapsulated, and combinations of the two can be used. In some embodiments at least some of the T1R2 sweetener in the gum composition is in a non-encapsulated form. When at least some of the T1R2 sweetener in the gum composition is encapsulated, the sweetness enhancer and sucralose may be encapsulated in a combined form. Alternatively the sweetness enhancer and T1R2 sweetener may be separately encapsulated.

[0018] The chewing gum composition will typically comprise between about 0.01% and about 2.5% one or more T1R2 sweeteners.

[0019] Preferred sweetness enhancers are selected from the group consisting of 4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1H)-one and salts, solvates, and esters thereof. This sweetness enhancer has been found to interact with the Venus fly trap domain of the T1R2 chemosensory receptor, thus providing a modulating activity so as to enhance the sweetness perceived from T1R2 sweeteners. In some embodiments the sweetness enhancer may be combined with a carrier prior to being mixed with the encapsulating agent. In such cases, the carrier may be selected from the group consisting of maltodextrin, starches, gum, hydrocolloids and mixtures thereof.

[0020] The chewing gum composition typically comprises between about 0.0002% and about 0.2% sweetness enhancer.

[0021] In some embodiments, the ratio of T1R2 sweetener to sweetness enhancer in the chewing gum composition is between about 1000:1 and about 5:1, preferably between about 125:1 and about 15:1, and more preferably between about 75:1 and about 25:1. In other embodiments, the level of sweetness enhancer is between about 0.01% and about 2% of the encapsulated material.

[0022] The sweetness enhancer probably releases slowly from chewing gum during the early stages of mastication of the gum because of its low solubility in water. Physical modifications of the sweetness enhancer by encapsulation with another substrate will increase or delay its release in chewing gum by modifying the solubility or dissolution rate of sweetness enhancer. Any standard technique which gives partial or full encapsulation of the sweetness enhancer can be used. These techniques include, but are not limited to, spray drying, spray chilling, fluid-bed coating and coacervation. These encapsulation techniques that give partial encapsulation or full encapsulation can be used individually or in any combination in a single step process or multiple step process.

[0023] The sweetness enhancer is preferably encapsulated with an encapsulating material selected from the group consisting of plastic polymers and copolymers, acrylic polymers and copolymers, and combinations thereof. A particularly preferred encapsulating material is polyvinyl acetate. The polyvinyl acetate preferably has a molecular weight of between about 2,000 and about 100,000 daltons. In some embodiments the encapsulating material comprises a combination of polyvinyl acetates, at least one of the polyvinyl acetates having a molecular weight of between about 9,000 and about 200,000 daltons and at least one of the polyvinyl acetates having a molecular weight of greater than 300,000 daltons. The ratio of sweetness enhancer to encapsulating material in the encapsulated sweetness enhancer is preferably between about 1:9000 and about 1:20. When the T1R2 sweetener is encapsulated with the sweetness enhancer, the ratio of the combined T1R2 sweetener and sweetness enhancer to encapsulating material is preferably between about 1.3:1 and about 1:9.

[0024] In other embodiments, examples of suitable polymers for the encapsulation of the sweetness enhancer include polyvinyl acetate, hydroxypropyl cellulose, hydroxypropylmethyl cellulose, polyethylene, carboxyvinyl polymer, polyamides, polystyrene, polyvinyl acetate phthalate, polyvinylpyrrolidone, and combinations thereof.

[0025] In still other embodiments the encapsulating material may be selected from cross-linked polyvinyl pyrrolidone, polymethylmethacrylate, polylacticacid, polyhydroxyalkanoates, ethylcellulose, polyethyleneglycol esters, and methacrylicacid-co-methylmethacrylate. More specifically the polymer will include polyvinyl acetate either alone or in combination with another polymer. In some embodiments, the polymer may have a molecular weight higher than about 300,000, specifically about 500,000 or higher.

[0026] An emulsifier may be included in the polyvinyl acetate. The emulsifier is preferably selected from the group consisting of lecithin, stearates, ester derivatives of stearates, palmitates, ester derivatives of palmitates, oleates, ester derivatives of oleates, glycerides, ester derivatives of glycerides, sucrose polyesters, polyglycerolesters, and animal waxes, vegetable waxes, synthetic waxes, petroleum wax and mixtures thereof. In another embodiment the encapsulating material comprises a polyvinyl acetate having a molecular weight of between about 20,000 and about 100,000 daltons, and a hydrophobic plasticizer selected from the group consisting of

mono-, di- and triglycerides, and ester derivatives thereof, having a fatty acid chain length of from about 16 to about 22 carbon atoms.

[0027] The encapsulation process is preferably selected from the group consisting of extrusion, spray chilling, fluid bed coating, agglomeration, coacervation and combinations thereof. Particularly preferred encapsulation processes include extrusion.

[0028] The encapsulation techniques here described are standard coating techniques and generally give varying degrees of coating, from partial to full coating, depending on the encapsulating composition used in the process. Also, the encapsulating compositions may be susceptible to water permeation to various degrees. Generally, compositions that have high organic solubility, good film-forming properties and low water solubility give better delayed release of the sweetness enhancer. Such compositions include acrylic polymers and copolymers, carboxyvinyl polymer, polyamides, polystyrene, polyvinyl acetate, polyvinyl acetate phthalate, polyvinylpyrrolidone, and waxes. Although all of these materials are possible for encapsulation of sweetness enhancer, only food-grade materials should be considered. Two standard food-grade encapsulating materials that are good film formers but not water soluble are shellac and Zein. Others which are more water soluble, but good film formers, are materials like agar, alginates, a wide range of cellulose derivatives like ethyl cellulose, methyl cellulose, sodium hydroxymethyl cellulose, and hydroxypropylmethyl cellulose, dextrin, gelatin, and modified starches. These ingredients, which are generally approved for food use, give a fast release when used as an encapsulant for sweetness enhancer. Other encapsulants like acacia or maltodextrin can also encapsulate sweetness enhancer, and give a fast release of sweetness enhancer in gum.

[0029] The amount of coating or encapsulating material on the sweetness enhancer also controls the length of time for its release from chewing gum. Generally, the higher the level of water-insoluble coating and the lower the amount of active sweetness enhancer, the slower the release of the sweetness enhancer during mastication. Also, the higher the usage level of a water-soluble coating, the slower the release rate. The release may be instantaneous, or gradual over an extended period of time. To obtain the desired sweetness release to blend with a gum's flavor release, the encapsulant should be a minimum of about 10% of the coated sweetness enhancer. Preferably, the encapsulant should be a minimum of about 20% to about 50% of the coated sweetness enhancer. Depending on the encapsulating material, a higher or lower amount of

encapsulating material may be needed to give the desired release of sweetness enhancer to balance sweetness enhancer release with T1R2 sweetener and flavor release.

[0030] Another method of giving a modified release of the sweetness enhancer is agglomeration of the sweetness enhancer with an agglomerating agent which partially coats the sweetness enhancer. This method includes the step of mixing the sweetness enhancer and agglomerating agent with a small amount of water or solvent. The mixture is prepared in such a way as to have individual wet particles in contact with each other so that a partial coating can be applied. After the water or solvent is removed, the mixture is ground and used as a powdered, coated sweetness enhancer.

[0031] Materials that can be used as the agglomerating agent are the same as those used in encapsulation procedures mentioned previously. However, since the coating is only a partial encapsulation, and the sweetness enhancer is slightly water-soluble, some agglomerating agents are more effective in modifying the sweetness enhancer release than others. Some of the better agglomerating agents are the organic polymers like acrylic polymers and copolymers, polyvinyl acetate, polyvinylpyrrolidone, waxes, shellac, and Zein. Other agglomerating agents are not as effective in giving the sweetness enhancer a delayed release as are the polymers, waxes, shellac and Zein, but may actually give a faster release. Other agglomerating agents include, but are not limited to, agar, alginates, a wide range of cellulose derivatives like ethyl cellulose, methyl cellulose, sodium hydroxymethyl cellulose, hydroxypropylmethyl cellulose, dextrin, gelatin, modified starches, and vegetable gums like guar gum, locust bean gum, and carrageenin. Even though the agglomerated sweetness enhancer is only partially coated, when the quantity of coating is increased compared to the quantity of sweetness enhancer, the release of the sweetness enhancer can be delayed for a longer time during mastication. The level of coating used in the agglomerated product is a minimum of about 5%. Preferably the coating level is a minimum of about 15% and more preferably about 20%. Depending on the agglomerating agent, a higher or lower amount of agent may be needed to give the desired release of sweetness enhancer to balance sweetness enhancer release with T1R2 sweetener and flavor release.

[0032] The sweetness enhancer may be coated in a two-step process or multiple step process. The sweetness enhancer may be encapsulated with any of the materials as described previously and then the encapsulated sweetness enhancer can be agglomerated as described previously to obtain an

encapsulated/agglomerated/sweetness enhancer product that could be used in chewing gum to give a delayed release of sweetness enhancer.

[0033] In another embodiment of this invention, sweetness enhancer may be absorbed onto another component which is porous and become entrapped in the matrix of the porous component. Common materials used for absorbing the sweetness enhancer include, but are not limited to, silicas, silicates, pharmasorb clay, spongelike beads or microbeads, amorphous sugars like spray-dried dextrose, sucrose, alditols, amorphous carbonates and hydroxides, including aluminum and calcium lakes, vegetable gums and other spray dried materials. Insoluble materials will give sweetness enhancer a delayed release, while water-soluble materials will give sweetness enhancer a fast release from chewing gum.

[0034] Depending on the type of absorbent material and how it is prepared, the amount of sweetness enhancer that can be loaded onto the absorbent will vary. Generally materials like polymers or spongelike beads or microbeads, amorphous sugars and alditols and amorphous carbonates and hydroxides absorb an amount equal to about 10% to about 40% of the weight of the absorbent. Other materials like silicas and pharmasorb clays may be able to absorb about 20% to about 80% of the weight of the absorbent.

[0035] The general procedure for absorbing the sweetness enhancer onto the absorbent is as follows. An absorbent like fumed silica powder can be mixed in a powder blender and an aqueous solution of the sweetness enhancer can be sprayed onto the powder as mixing continues. The aqueous solution can be about 0.1% sweetness enhancer solids, and higher solid levels may be used if temperatures up to 90ºC are used. Generally water is the solvent, but other solvents like alcohol could also be used if approved for use in food. As the powder mixes, the liquid is sprayed onto the powder. Spraying is stopped before the mix becomes damp. The still free-flowing powder is removed from the mixer and dried to remove the water or other solvent, and then ground to a specific particle size.

[0036] After the sweetness enhancer is absorbed onto an absorbent or fixed onto an absorbent, the fixative/sweetness enhancer can be coated by encapsulation. Either full or partial encapsulation may be used, depending on the coating composition used in the process. Full encapsulation may be obtained by coating with a polymer as in spray drying, spray chilling, fluid-bed coating, coacervation, or any other standard technique.

A partial encapsulation or coating can be obtained by agglomeration of the fixative/sweetness enhancer mixture using any of the materials discussed above.

[0037] Another form of encapsulation is by entrapment of an ingredient by extrusion, fiber extrusion or fiber spinning into a polymer. Polymers that can be used for extrusion are polyvinyl acetate (PVAC), hydroxypropyl cellulose, polyethylene and other types of plastic polymers. A process of encapsulation by extrusion is disclosed in U.S. Patent No. 5,169,658, which is hereby incorporated by reference. PVAC may be heat-softened and then homogeneously mixed with an ingredient. The PVAC and other ingredient may be at room temperature and added to the extruder at the same time, where the softening and mixing then occurs. This homogeneous mixture is then extruded, cooled and ground. A process of encapsulation by fiber extrusion is disclosed in U.S. Patent No. 4,978,537, which is hereby incorporated by reference. The water insoluble polymer may be preblended with the sweetness enhancer prior to fiber extrusion, or may be added after the polymer is melted. As the extrudate is extruded, it results in small fibers that are cooled and ground. This type of encapsulation/entrapment generally gives a very long, delayed release of an active ingredient. In the '537 patent it is noted that the sweetener may have a loading of more than zero but less than about 55% of the extruded material, and more particularly a level of between about 10% and about 55% of the extruded material. The sweetness enhancer may have similar loadings. In the examples in the '537 patent, PVACs having a variety of molecular weights were used: about 15,000; about 30,000; about 100,000; from about 50,000 to about 80,000, or a blend of PVACs having molecular weights from about 15,000 to about 100,000.

[0038] The four primary methods to obtain a modified release of the sweetness enhancer are: (1) encapsulation by spray drying, fluid-bed coating, spray chilling and coacervation to give full or partial encapsulation, (2) agglomeration to give partial encapsulation, (3) fixation or absorption which also gives partial encapsulation, and (4) entrapment into an extruded compound. These four methods, combined in any usable manner which physically modifies the release or dissolvability of the sweetness enhancer are included in this invention.

[0039] The previously described encapsulated, agglomerated, absorbed, or extruded sweetness enhancer may readily be incorporated into a chewing gum composition. The remainder of the chewing gum ingredients are noncritical to the present invention. That is, the coated particles of sweetness enhancer can be

incorporated into conventional chewing gum formulations in a conventional manner. Naturally, the preferred chewing gum formulation is a sugarless chewing gum. However, the T1R2 sweetener and sweetness enhancer may also be used in a sugar chewing gum to intensify and/or extend the sweetness thereof. The coated sweetness enhancer may be used in either regular chewing gum or bubble gum.

[0040] In general, a chewing gum composition typically comprises a water-soluble bulk portion, a water-insoluble chewable gum base portion and typically water-insoluble flavoring agents. The water-soluble portion dissipates with a portion of the flavoring agent over a period of time during chewing. The gum base portion is retained in the mouth throughout the chew.

[0041] The insoluble gum base generally comprises elastomers, resins, fats and oils, waxes, softeners and inorganic fillers. Elastomers may include polyisobutylene, isobutylene-isoprene copolymer and styrene butadiene rubber, as well as natural latexes such as chicle. Resins include polyvinylacetate and terpene resins. Fats and oils may also be included in the gum base, including tallow, hydrogenated and partially hydrogenated vegetable oils, and cocoa butter. Commonly employed waxes include paraffin, microcrystalline and natural waxes such as beeswax and carnauba. According to the preferred embodiment of the present invention, the insoluble gum base constitutes between about 5 to about 95 percent by weight of the gum. More preferably the insoluble gum base comprises between 10 and 50 percent by weight of the gum and most preferably about 20 to about 35 percent by weight of the gum.

[0042] The gum base typically also includes a filler component. The filler component may be calcium carbonate, magnesium carbonate, talc, dicalcium phosphate or the like. The filler may constitute between about 5 and about 60 percent by weight of the gum base. Preferably, the filler comprises about 5 to about 50 percent by weight of the gum base.

[0043] Gum bases typically also contain softeners, including glycerol monostearate and glycerol triacetate. Further, gum bases may also contain optional ingredients such as antioxidants, colors, and emulsifiers. The present invention contemplates employing any commercially acceptable gum base.

[0044] The water-soluble portion of the chewing gum may further comprise softeners, other sweeteners in addition to the one or more T1R2 sweeteners, flavoring agents and combinations thereof. Softeners are added to the chewing gum in order to optimize the chewability and mouth feel of the gum. Softeners, also known in the art as

plasticizers or plasticizing agents, generally constitute between about 0.5 to about 15.0 percent by weight of the chewing gum. Softeners contemplated by the present invention include glycerin, lecithin, and combinations thereof. Further, aqueous sweetener solutions such as those containing sorbitol, hydrogenated starch hydrolysates, corn syrup and combinations thereof may be used as softeners and binding agents in gum.

[0045] As mentioned above, the treated sweetness enhancer of the present invention will most likely be used in sugarless gum formulations. However, formulations containing sugar are also within the scope of the invention. Sugar sweeteners generally include saccharide-containing components commonly known in the chewing gum art which comprise, but are not limited to, sucrose, dextrose, maltose, dextrin, dried invert sugar, fructose, galactose, corn syrup solids and the like, alone or in any combination.

[0046] The one or more T1R2 sweeteners and treated sweetness enhancer of the present invention can also be used in combination with other sugarless sweeteners. Generally sugarless sweeteners include components with sweetening characteristics but which are devoid of the commonly known sugars and comprise, but are not limited to, sugar alcohols such as sorbitol, mannitol, xylitol, hydrogenated starch hydrolysates, maltitol, lactitol, erythritol and the like, alone or in any combination. In some embodiments, the chewing gum composition includes an additional high-potency sweetener selected from the group consisting of alitame, acesulfame and its salts, cyclamate and its salts, saccharin and its salts, thaumatin, monellin, dihydrochalcones, glycyrrhizin, stevia and steviol glycosides, and combinations thereof.

[0047] A flavoring agent may be present in the chewing gum in an amount within the range of from about 0.1 to about 10.0 weight percent and preferably from about 0.5 to about 3.0 weight percent of the gum. The flavoring agents may comprise essential oils, synthetic flavors, or mixture thereof including, but not limited to, oils derived from plants and fruits such as citrus oils, fruit essences, peppermint oil, spearmint oil, clove oil, oil of wintergreen, anise, and the like. Artificial flavoring components are also contemplated for use in gums of the present invention. Those skilled in the art will recognize that natural and artificial flavoring agents may be combined in any sensorally acceptable blend. All such flavors and flavor blends are contemplated by the present invention.

[0048] Optional ingredients such as colors, emulsifiers and pharmaceutical agents may be added to the chewing gum.

[0049] In general, chewing gum is manufactured by sequentially adding the various chewing gum ingredients to a commercially available mixer known in the art. After the ingredients have been thoroughly mixed, the gum mass is discharged from the mixer and shaped into the desired form such as by rolling into sheets and cutting into sticks, extruding into chunks or casting into pellets.

[0050] Generally, the ingredients are mixed by first melting the gum base and adding it to the running mixer. The base may also be melted in the mixer itself. Color or emulsifiers may also be added at this time. A softener such as glycerin may also be added at this time, along with syrup and a portion of the bulking agent. Further portions of the bulking agent may then be added to the mixer. A flavoring agent is typically added with the final portion of the bulking agent. The coated sweetness enhancer of the present invention is preferably added after the final portion of bulking agent and flavor have been added.

[0051] The entire mixing procedure typically takes from five to fifteen minutes, but longer mixing times may sometimes be required. Those skilled in the art will recognize that many variations of the above described procedure may be followed.

[0052] In some embodiment, the process of making the chewing gum involves the steps of a) mixing a quantity of a sweetness enhancer with an encapsulating agent in such a way as to encapsulate the sweetness enhancer in order to modify the rate of release of the sweetness enhancer in the chewing gum; and b) adding a quantity of the encapsulated sweetness enhancer and a quantity of one or more T1R2 sweeteners to a chewing gum formulation to provide a sweetness enhancer level in the chewing gum formulation of from about 0.0002% to about 0.2%.

[0053] In other embodiments, a process for making chewing gum which includes the steps of a) preparing a gum base; b) preparing a water soluble bulk portion; c) preparing a gradual release structure which comprises the steps of: i) preparing a mixture of a sweetness enhancer and encapsulating material, having a ratio of sweetness enhancer to encapsulating material of between about 1:1800 and about 1:4, thereof; ii) extruding the mixture; and iii) grinding the extruded mixture into a gradual release structure; and, d) combining the gradual release structure, the gum base and the water soluble bulk portion.

[0054] As noted above, the one or more T1R2 sweeteners and sweetness enhancer may be mixed together before mixing with the encapsulating agent so that the one or more T1R2 sweeteners and sweetness enhancer are encapsulated together.

EXAMPLES

[0055] The following examples of the invention and comparative examples are provided by way of explanation and illustration.

[0056] The formulas listed in Table 1 comprise several different sucralose and sweetness enhancer combinations, which were encapsulated with different molecular weights of polyvinyl acetate.

TABLE 1

	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
	%	%	%	%	%
Sucralose	20	20	20	20	40
Sweetness Enhancer*	0	0.266	0	0.266	0.266
Medium MW PVAC**	80	79.734	0	0	0
High MW PVAC***	0	0	80	79.734	59.734
Total	100	100	100	100	100

*4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1H)-one
** MW between 25,000 and 30,000 daltons, and a small amount of a carrier used with the Sweetness Enhancer
*** MW between 80,000 and 100,000 daltons, and a small amount of a carrier used with the Sweetness Enhancer

[0057] In general, the process used to perform the encapsulation in Samples 1-5 used the following procedure. The dry blended ingredients were fed to a twin screw extruder with counter-rotating screws. A gravimetric feeder was used to feed the ingredients. The ingredients were mixed inside the twin screw extruder under conditions of high shear at temperatures above the glass transition temperature of the polyvinyl acetate. Preferably, the maximum temperature achieved by the mixture in the extruder is about 100°C. Preferably, the average residence time of the ingredients inside the extruder is less than about 45 seconds.

[0058] It can be seen that Samples 1 and 3 included just encapsulated sucralose, and no encapsulated sweetness enhancer. Samples 2, 4 and 5 included both sucralose and sweetness enhancer encapsulated together, with different molecular weights of polyvinyl acetate and different ratios of sucralose and sweetness enhancer to polyvinyl acetate.

[0059] This mixing of the sucralose, or sucralose and sweetness enhancer, and molten polyvinyl acetate in the extruder, followed by subsequent cooling, resulted in the encapsulation of the sucralose, or sucralose and sweetness enhancer, in the matrix of polyvinyl acetate. After leaving the extruder, the encapsulation blend was cooled until the polyvinyl acetate returned to its solid state. The encapsulation mixture was pelletized and ground into powder using standard pelletizing and grinding equipment, making it ready to be added to a chewing gum formula.

[0060] Table 2 lists chewing gum formulations that were made with sucralose as a control (Comparative Example A) and with sucralose and sweetness enhancer (neither of which were encapsulated).

TABLE 2

	Comparative Example A	Comparative Example B	Comparative Example C	Comparative Example D
	%	%	%	%
Sugarless Syrup*	34.00	34.06	34.09	34.053
Sorbitol	32.80	32.80	32.80	32.80
Gum base	27.00	27.00	27.00	27.00
Flavor	2.95	2.95	2.95	2.95
Encapsulated aspartame	1.00	1.00	1.00	1.00
Twinsweet (Aspartame/ Acesulfame K)	0.60	0.60	0.60	0.60
Citric Acid	0.50	0.50	0.50	0.50
Malic Acid	0.30	0.30	0.30	0.30
Fumaric Acid	0.10	0.10	0.10	0.10
Acetylated Monoglycerides	0.30	0.30	0.30	0.30
Color (in water and glycerol)	0.30	0.30	0.30	0.30
Sucralose (neat)	0.15	0.075	0.05	0.075
Sweetness Enhancer (neat)	0.00	0.011	0.011	0.022
Total	100.00	100.00	100.00	100.00

*Sugarless syrup contains sorbitol, glycerin, Hydrogenated Starch Hydrolysates, water and mannitol

[0061] Figure 1 shows test results for the gum formulations of Table 2. Six panelists each chewed the four different formulations of Table 2 and rated them as to their sweetness intensity at different lengths of time since the gum started to be chewed. As can be seen from Figure 1, it was learned that the sweetness enhancer was effective in chewing gum. Even though the level of sucralose was reduced by 50% or more in Comparative Examples B, C and D compared to Comparative Example A, the sweetness levels for all of these Comparative Examples were very similar. The chew-out test was only carried out for 6 minutes because from other testing it was learned that approximately 88% of neat sucralose is chewed out from gum in 6 minutes of chewing.

[0062] Table 3 lists three chewing gum compositions that were made and tested, one serving as a control and two formulations according to the present invention.

TABLE 3

	Comparative Example E	Example 1	Example 2
	%	%	%
Sugarless Syrup*	34.00	34.00	34.00
Sorbitol	32.18	32.18	32.90
Gum base	27.00	27.00	27.00
Flavor	2.95	2.95	2.95
Citric Acid	0.50	0.50	0.50
Malic Acid	0.30	0.30	0.30
Fumaric Acid	0.10	0.10	0.10
Acetylated Monoglycerides	0.30	0.30	0.30
Color (in water and glycerol)	0.30	0.30	0.30
Sucralose	0.15	0.15	0.15
Encapsulated Sucralose (Sample 1)	2.22	-	-
Encapsulated Sucralose and Sweetness Enhancer (Sample 2)	-	2.22	1.50
Total	100.00	100.00	100.00

*Sugarless syrup contains sorbitol, glycerin, Hydrogenated Starch Hydrolysates, water and mannitol

[0063] Figure 2 shows test results for the gum formulations of Table 3. Seven panelists each chewed the three different formulation of Table 3 and rated them as to their sweetness intensity at different lengths of time since the gum started to be chewed. As can be seen from Figure 2, with the present invention, a long duration sweetness was able to be achieved in the chewing gums of Examples 1 and 2. Also, even though Example 2 contained only about 2/3 of the amount of sucralose as the control, as seen in Figure 2 it still had a sweetness intensity greater than Comparative Example E for the entire 12 minutes of testing.

[0064] It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art after reading the forgoing. For example, different molecular weights of polyvinyl acetate can be used to modify the release rate of the sweetness enhancer. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

WE CLAIM:

1. A chewing gum composition comprising:
   a) a gum base; and
   b) a water soluble bulk portion comprising:
      i) at least one T1R2 sweetener encapsulated with a first encapsulating material and
      ii) a sweetness enhancer encapsulated with a second encapsulating material, the sweetness enhancer being selected from the group consisting of 4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1H)-one and salts, solvates, and esters thereof.

2. The chewing gum composition of claim 1 wherein the gum composition also includes at least one T1R2 sweetener in a non-encapsulated form.

3. The chewing gum composition of any one of claims 1 to 2 wherein the sweetness enhancer and at least one T1R2 sweetener are separately encapsulated.

4. The chewing gum composition of any one of claims 1 to 3 wherein the sweetness enhancer is encapsulated with an encapsulating material selected from the group consisting of plastic polymers and copolymers, acrylic polymers and copolymers, and combinations thereof.

5. The chewing gum composition of any one of claims 1 to 4 wherein the chewing gum composition comprises between about 0.0002% and about 0.2% sweetness enhancer.

6. The chewing gum composition of any one of claims 1 to 5 wherein the at least one T1R2 sweetener comprises sucralose, and the chewing gum composition comprises between about 0.01% and about 2.5% sucralose.

7. The chewing gum composition of claim 6 wherein the ratio of sucralose to sweetness enhancer in the chewing gum composition is between about 1000:1 and about 5:1.

8. The chewing gum composition of claim 7 wherein the ratio of sucralose to sweetness enhancer in the chewing gum composition is between 125:1 and about 15:1.

9. The chewing gum composition of claim 8 wherein the ratio of sucralose to sweetness enhancer in the chewing gum composition is between about 75:1 and about 25:1.

10. The chewing gum composition of any one of claims 1 to 9 wherein the ratio of sweetness enhancer to encapsulating material in the encapsulated sweetness enhancer is between about 1:9000 and about 1:20.

11. The chewing gum composition of any one of claims 1 to 10 wherein the first and second encapsulating agents are the same material.

12. The chewing gum composition of claim 11 wherein the sweetness enhancer and at least one T1R2 sweetener are encapsulated in a combined form.

13. The chewing gum composition of claim 12 wherein the ratio of the combined at least one T1R2 sweetener and sweetness enhancer to encapsulating material is between about 1.3:1 and about 1:9.

14. The chewing gum composition of any one of claims 1 to 13 further comprising an additional high-potency sweetener selected from the group consisting of alitame, acesulfame and its salts, cyclamate and its salts, saccharin and its salts, thaumatin, monellin, dihydrochalcones, glycyrrhizin, stevia and steviol glycosides, and combinations thereof.

15. The chewing gum composition of any one of claims 1 to 14 wherein the sweetness enhancer is encapsulated with polyvinyl acetate.

16. The chewing gum composition of claim 15 wherein the polyvinyl acetate has a molecular weight of between about 2,000 and about 100,000 daltons.

17. The chewing gum composition of any one of claims 15 to 16 wherein an emulsifier is included in the polyvinyl acetate.

18. The chewing gum composition of claim 17 wherein the emulsifier is selected from the group consisting of lecithin, stearates, ester derivatives of stearates, palmitates, ester derivatives of palmitates, oleates, ester derivatives of oleates, glycerides, ester derivatives of glycerides, sucrose polyesters, polyglycerolesters, and animal waxes, vegetable waxes, synthetic waxes, petroleum wax and mixtures thereof.

19. A method of producing a chewing gum product containing a physically-modified sweetness enhancer in order to control the release rate of sweetness enhancer comprising the steps of:

a) mixing a quantity of a sweetness enhancer with an encapsulating agent in such a way as to encapsulate the sweetness enhancer in order to modify the rate of release of the sweetness enhancer in the chewing gum, the sweetness enhancer being selected from the group consisting of 4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1H)-one and salts, solvates, and esters thereof; and

b) adding a quantity of the encapsulated sweetness enhancer and a quantity of at least one T1R2 sweetener that is also encapsulated to a chewing gum formulation to provide a sweetness enhancer level in the chewing gum formulation of from about 0.0002% to about 0.2%.

20. The method of claim 19 wherein the at least one T1R2 sweetener comprises sucralose.

21. The method of any one of claims 19 to 20 wherein the at least one T1R2 sweetener and sweetness enhancer are mixed together before mixing with the encapsulating agent so that the at least one T1R2 sweetener and sweetness enhancer are encapsulated together.

22. The method of any one of claims 19 to 21 wherein the sweetness enhancer is combined with a carrier prior to being mixed with the encapsulating agent.

23. The method of claim 22 wherein the carrier is selected from the group consisting of maltodextrin, starches, gum, hydrocolloids and mixtures thereof.

24. The method of any one of claims 19 to 23 wherein the encapsulating agent is selected from the group consisting of polyvinyl acetate, hydroxypropyl cellulose, hydroxypropylmethyl cellulose, polyethylene, carboxyvinyl polymer, polyamides, polystyrene, polyvinyl acetate phthalate, polyvinylpyrrolidone, and combinations thereof.

25. The method of any one of claims 19 to 24 wherein the level of sweetness enhancer is between about 0.01% and about 2% of the encapsulated material.

26. The method of any one of claims 19 to 25 wherein the encapsulated material is ground prior to being added to the chewing gum.

27. The method of any one of claims 19 to 26 wherein the encapsulation process of step a) is selected from the group consisting of extrusion, spray chilling, fluid-bed coating, agglomeration, coacervation and combinations thereof.

28. The method of any one of claims 19 to 27 wherein the encapsulation step comprises extrusion.

29. The method of any one of claims 19 to 28 in which the encapsulating agent comprises polyvinyl acetate having a molecular weight of between about 2,000 and about 100,000 daltons.

30. The method of any one of claims 19 to 29 wherein an additional high-potency sweetener selected from the group consisting of alitame, acesulfame and its salts, cyclamate and its salts, saccharin and its salts, thaumatin, monellin, dihydrochalcones, glycyrrhizin, stevioside and combinations thereof is mixed in the chewing gum composition.

31. A process for making chewing gum which comprises the steps of:

a) preparing a gum base;

b) preparing a water soluble bulk portion;

c) preparing a gradual release structure which comprises the steps of:

i) preparing a mixture of a sweetness enhancer and encapsulating material, having a ratio of sweetness enhancer to encapsulating material of between about 1:1800 and about 1:4, the sweetness enhancer being selected from the group consisting of 4-amino-5,6-dimethylthieno[2,3-d]pyrimidin-2(1H)-one and salts, solvates, and esters thereof;

ii) extruding the mixture; and

iii) grinding the extruded mixture into a gradual release structure; and,

d) combining the gradual release structure, and the gum base and the water soluble bulk portion, wherein the combination also includes at least one encapsulated T1R2 sweetener.

32. The process of claim 31 wherein the at least one T1R2 sweetener comprises sucralose.

33. The process of any one of claims 31 to 32 in which the encapsulating material comprises a combination of polyvinyl acetates, at least one of the polyvinyl acetates having a molecular weight of between about 9,000 and about 200,000 daltons and at least one of the polyvinyl acetates having a molecular weight of greater than 300,000 daltons.

34. The process of any one of claims 31 to 33 in which the encapsulating material comprises a polyvinyl acetate having a molecular weight of between about 20,000 and about 100,000 daltons, and a hydrophobic plasticizer selected from the group consisting of mono-, di- and triglycerides, and ester derivatives thereof, having a fatty acid chain length of from about 16 to about 22 carbon atoms.

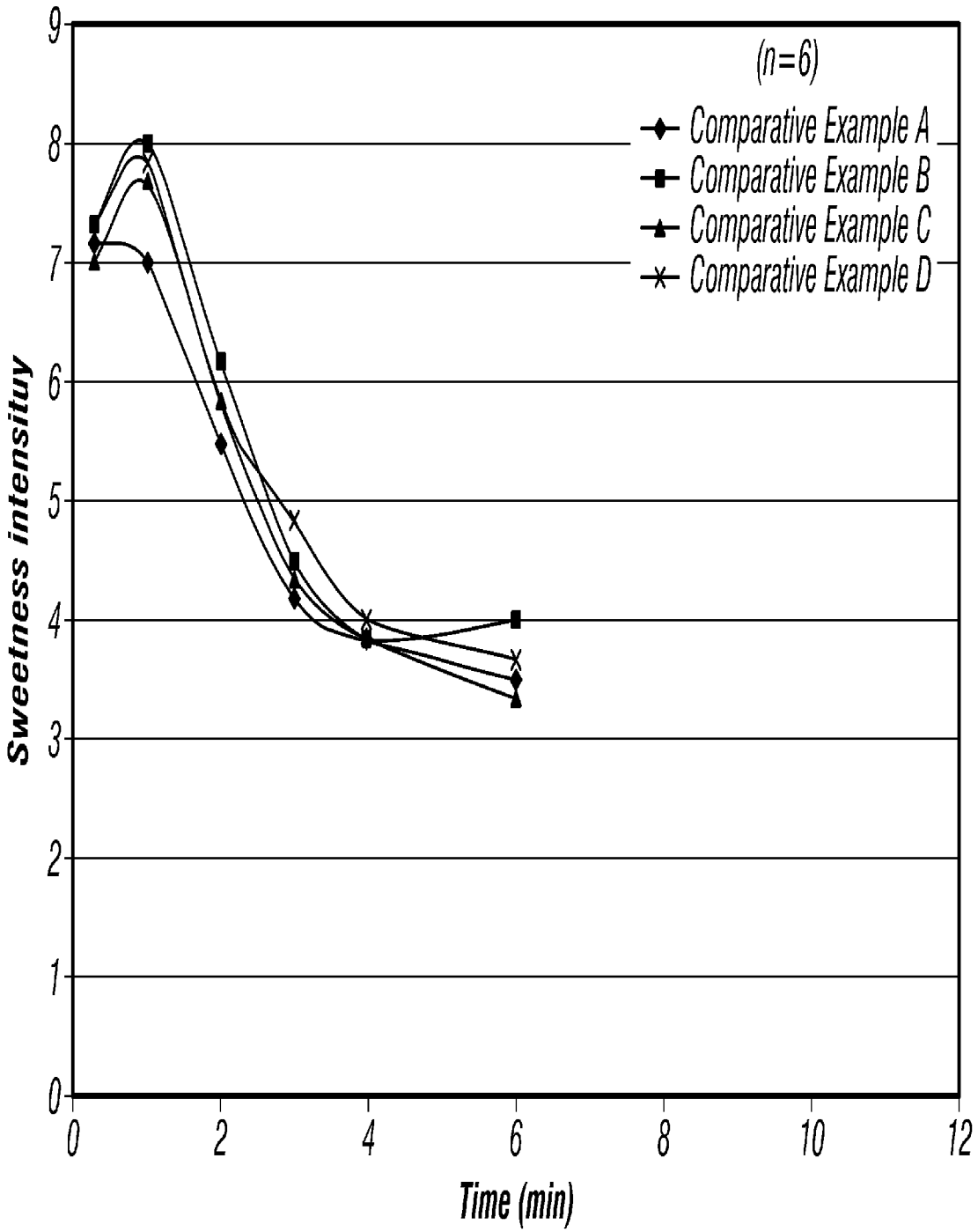
(n=6)
Comparative Example A
Comparative Example B
Comparative Example C
Comparative Example D
Sweetness intensituy
Time (min)
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12

FIG. 1

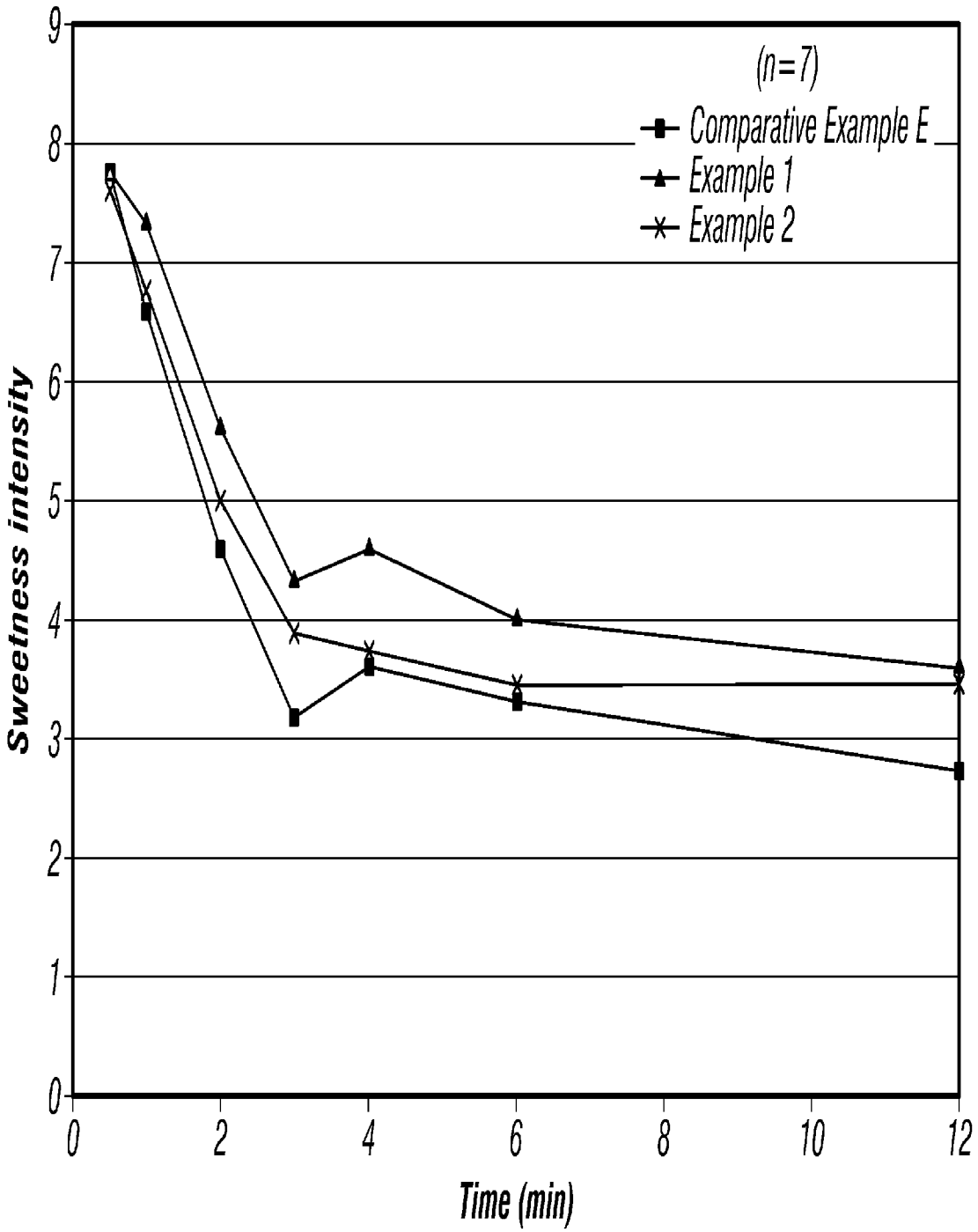
(n=7)
Comparative Example E
Example 1
Example 2
Sweetness intensity
Time (min)
0
1
2
3
4
5
6
7
8
9
0
2
4
6
8
10
12

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/061650

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A23G 4/10 (2014.01)
USPC - 426/5
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - A23G 4/00, 4/06, 4/10, 4/20 (2014.01)
USPC - 426/3, 5, 6

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - A23G 4/06, 4/10, 4/20 (2013.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Orbit.com, Google Patents, Public AppFT and PatFT, Google Scholar

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2009/0028998 A1 (ELEJALDE et al) 29 January 2009 (29.01.2009) entire document	1-3, 19-21, 31-33
Y	US 2008/0306053 A1 (TACHDJIAN et al) 11 December 2008 (11.12.2008) entire document	1-3, 19-21, 31-33
Y	US 2006/0068057 A1 (BOGHANI et al) 30 March 2006 (30.03.2006) entire document	31-33

☐ Further documents are listed in the continuation of Box C. ☐

* 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
"T" 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 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
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 January 2014	07 FEB 2014

Name and mailing address of the ISA/US	Authorized officer:
Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/061650

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☒ Claims Nos.: 4-18, 22-30, 34
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☐ No protest accompanied the payment of additional search fees.