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(54) Title: BALANCING HEAT OF SOLUTION IN NON-FREE FLOWING SWEETENER COMPOSITIONS

(57) Abstract: Cohesive non-free flowing sweetener composition for adding sweetness to liquid foodstuffs, for example, beverages, having a reduced caloric burden as compared to a conventional sucrose cubes of the same dimensions, are provided. More particularly, a cohesive non-free flowing sweetener composition containing a high intensity sweetener and a bulking agent with a negative heat of solution in an amount sufficient to produce a total heat of solution in the cohesive non-free flowing sweetener composition of from about 5 kilocalories to about -20 kilocalories, and a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions. Also provided is a sweetener cube comprising a high intensity sweetener, a bulking agent, and a compound with a positive heat of solution in an amount sufficient to produce a total heat of solution in the sweetener cube between about 5 kilocalories and about -20 kilocalories, wherein the cohesive non-free flowing sweetener composition has a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions. Methods of making such sweetener cubes are also provided.

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BALANCING HEAT OF SOLUTION IN NON-FREE FLOWING SWEETENER COMPOSITIONS

FIELD OF THE INVENTION

[0001] The present invention relates to cohesive non-free flowing sweetener compositions with decreased caloric burden compared to conventional sucrose cubes of similar size for delivering sweetness to a liquid foodstuff, for example, a beverage. More particularly, the present invention relates to a cohesive non-free flowing sweetener composition containing a high intensity sweetener and a bulking agent with a negative heat of solution in an amount sufficient to produce a total heat of solution in the cohesive non-free flowing sweetener composition between about 5 kilocalories and about -20 kilocalories, wherei the cohesive non-free flowing sweetener compositions has a lower caloric burden and an equivalent sweetness. compared to that of a conventional sucrose cube of about the same dimensions. In addition, the present invention relates to a cohesive non-free flowing sweetener composition containing a high intensity sweetener, a bulking agent, and a compound with a positive heat of solution in an amount sufficient to produce a total heat of solution in the sweetener cube between about 5 kilocalories and about -20 kilocalories, wherein the cohesive non-free flowing sweetener composition has a lower caloric burden and equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions. The present invention further relates to methods of making such cohesive non-free flowing sweetener compositions.

BACKGROUND OF THE INVENTION

[0002] People often add sweeteners to their foods and beverages. For example, sweeteners are added to beverages, such as, coffee and tea. Sweetening a food or beverage alters its flavor and usually increases its appeal. This behavior is found in all cultures, but is especially prevalent in western cultures.

[0003] In certain markets, for example, France, display this behavior to a greater or lesser extent, where a proportion of sweetener consumption is of the sweetening product alone without incorporating the sweetener in a beverage or a foodstuff. In these cases the preferred sweetening product is in the form of a cube of sugar (sucrose) or similar product.

[0004] Personal taste creates considerable variability in the amount of sweetness that one person prefers in a given food or beverage versus another person. For example, the amount of sweetness incorporated into a foodstuff during commercial production may not be adequate to satisfy some consumers while other consumers may find that the same amount of sweetness to be excessive. Moreover, consumers often desire to reduce their caloric intake for health or lifestyle reasons. Therefore, there exists a long-felt need for sweetener products that consumers may use to increase the sweetness of a product at the time of consumption that are consistent with their personal preferences and minimize additional caloric burden.

[0005] Methods for sweetening liquid foodstuffs are known. For example, adding sweetener to an unsweetened iced tea beverage will typically involve adding the sweetener to the unsweetened iced tea beverage followed by stirring to disperse the sweetener to create a sweetened iced tea beverage. Such a sweetener is typically in a cube, tablet, granular, powdered, or liquid form.

[0006] Sweetening individual servings of a beverage presents a challenge in many food service situations. Frequently, an individual packet of a sweetener is provided along with a serving of a beverage. The packet may contain sucrose, or alternatively may contain high intensity sweeteners such as sucralose, aspartame, or saccharin and a standard bulking agent such as sucrose, glucose or maltodextrin; all of which have a typical calorific value of 4 kilocalories per gram. The user must open the packet and empty the contents into the beverage, and then stir the beverage to obtain dissolution of the sweetener and its complete dispersion in the liquid. The residual packaging of the packet creates waste that may present disposal problems under many situations. Alternatively, sweetener may be provided in the form of single serve cohesive non-free flowing sweetener composition, which contains approximately one (or more) sucrose equivalent teaspoon(s) of sweetness (one sucrose equivalent teaspoon being about 4 to about 5 grams per teaspoon of sucrose). Typically, such sweetener cubes do not require individual packaging, and therefore, reduce the steps involved in sweetening the beverage and the waste associated with the sweetener.

[0007] Sweetener cubes are cohesive non-free flowing compositions that include bulking agents. Bulking agents are typically crystalline carbohydrates, such as, sucrose, which are also available in combination with high intensity sweeteners. More recently a number of lower caloric burden bulking agents have entered the market. Some of these lower caloric burden bulking agents have physical and sensory characteristics similar to sucrose, and others have only a few physical or sensory characteristics similar to sucrose and/or some undesirable characteristics.

[0008] The availability of high intensity sweeteners provide the ability to lower the caloric burden involved with sweetening a liquid foodstuff, e.g., individual servings of beverages. For example, sucralose is about 500 to about 600 times as sweet as sucrose (a.k.a. table sugar and cane sugar). One teaspoon of sucrose, which is about 4 to about 5 grams of sucrose, may be replaced by about 6.7 to about 10 milligrams of sucralose. The minute quantities of high intensity sweeteners needed to achieve preferred sweetening of individual servings offer the opportunity to provide new technologies to deliver sweetness to foodstuffs, including individual servings.

[0009] In view of the foregoing, it would be advantageous to provide a cohesive non-free flowing sweetener composition with a lower caloric burden that has physical and sensory characteristics similar to those of a sucrose cube that may be manufactured commercially and is convenient for the consumer.

SUMMARY OF THE INVENTION

[00010] One embodiment of the present invention is a cohesive non-free flowing sweetener composition comprising, consisting of, and/or consisting essentially of a high intensity sweetener and a bulking agent having a negative heat of solution in an amount sufficient to produce a total heat of solution in the cohesive non-free flowing sweetener composition of from about 5 kilocalories to about -20 kilocalories, wherein the cohesive non-free flowing sweetener composition has a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions.

[00011] Another embodiment of the present invention is a cohesive non-free flowing sweetener composition comprising, consisting of, and/or consisting essentially of about 0.5% sucralose, about 80% maltose, and about 20% erythritol by weight based on the total weight of the sweetener cube, wherein the cohesive non-free flowing sweetener composition has a total heat of solution from about 5 kilocalories to about -20 kilocalories, and a lower caloric burden and an equivalent sweetness to that of a conventional sucrose cube of the same dimensions.

[00012] A further embodiment of the present invention is a cohesive non-free flowing sweetener composition comprising, consisting of, and/or consisting essentially of a high intensity sweetener, a bulking agent, and a compound with a positive heat of solution in an amount sufficient to produce a total heat of solution in the sweetener cube of from about 5 kilocalories to about -20 kilocalories, wherein the cohesive non-free flowing sweetener composition has a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions.

[00013] An additional embodiment of the present invention is a cohesive non-free flowing sweetener composition comprising, consisting of, and/or consisting essentially of about 0.3% to about 0.6% sucralose, about 10% to about 60% erythritol, about 4% to about 10% polydextrose, and about 10% to about 60% trehalose by weight based on the total weight of the cohesive non-free flowing sweetener composition, wherein the cohesive non-free flowing sweetener composition has a total heat of solution between about 5 kilocalories and about -20 kilocalories, and a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions.

[00014] Another embodiment of the present invention is a cohesive non-free flowing sweetener composition comprising, consisting of, and/or consisting essentially of about 0.4% sucralose, about 10% polydextrose, about 40% trehalose, and about 49.6% erythritol by weight based on the total weight of the sweetener cube, wherein the sweetener cube has a total heat of solution between about 5 kilocalories and about -13 kilocalories, and a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions.

[00015] A further embodiment of the present invention is a method of making a cohesive non-free flowing sweetener composition comprising, consisting of, and/or consisting essentially of the steps of a) selecting a high intensity sweetener and a bulking agent with a negative heat of solution so that the total heat of solution of the sweetener cube made therefrom is between about 5 kilocalories and about -20 kilocalories; b) combining the components selected in step (a) to form a blend; c) adding water to the blend; d) forming the blend into a shape; and e) drying the shape.

[00016] An additional embodiment of the present invention is a method of making a cohesive non-free flowing sweetener composition comprising, consisting of, and/or consisting essentially of the steps of a) selecting a high intensity sweetener, a bulking agent,

and a compound with a positive heat of solution so that the total heat of solution of the sweetener cube made therefrom is between about 5 kilocalories and about -20 kilocalories; b) combining the components selected in step (a) to form a blend; c) adding water to the blend; d) forming the blend into a shape; and e) drying the shape.

DETAILED DESCRIPTION OF THE INVENTION

[00017] To reduce the caloric burden of a sucrose cube, the amount of sucrose is decreased, which results a smaller cube size. The sweetness lost due to the decreased amount of sucrose in the cube can be offset by incorporating high intensity sweeteners, such as, aspartame or acesulfame K into the cube formulation. While such a formulation does reduce the cube's caloric burden, this reduction is limited by the minimum size of the cube that can be manufactured and handled by the consumer. A review of products currently on the market revealed a minimum cube size of about 1.4 grams, which results in a sucrose-containing sweetener cube having about 5.6 kilocalories.

[00018] One embodiment of the present invention is a cohesive non-free flowing sweetener composition containing a high intensity sweetener and a bulking agent with a negative heat of solution in an amount sufficient to produce a total heat of solution in the cohesive non-free flowing sweetener composition of from about 5 kilocalories to about -20 kilocalories, wherein the cohesive non-free flowing sweetener composition has a lower caloric burden than that of a conventional sucrose cube of the same dimensions and an equivalent sweetness.

[00019] As used herein, all numerical ranges provided are intended to expressly include at least all numbers that fall between the endpoints of recited ranges.

[00020] As used herein, the term "conventional sucrose cube" means a rectangular prism of crystalline sucrose having a height, width, and depth from about 5 millimeters to about 20 millimeters. Typically, a conventional sucrose cube is about 15 millimeters on each side and has a caloric burden of about 25 kilocalories. As noted above, the smallest commercially available and consumer accepted high intensity sweetener/sucrose cubes have two sides that are about 12 millimeters by about 12 millimeters and four sides that are about 9 millimeters by about 12 millimeters and have a caloric burden of about 5.6 kilocalories and weight of about 1.4 grams.

High Intensity Sweetener

[00021] As used herein, the term "high intensity sweetener" means a substance that provides a high sweetness per unit mass as compared to sucrose and provides little or no nutritive value.

[00022] Many high intensity sweeteners are known to those skilled in the art and any can be used in the present invention. Examples of high intensity sweeteners for use in the present invention include aspartame, acesulfame, alitame, brazzein, cyclamic acid, dihydrochalcones, extract of Dioscorophyllum cumminsii, extract of the fruit of Pentadiplandra brazzeana, glycyrrhizin, hernandulcin, monellin, mogroside, neotame, neohesperidin, saccharin, sucralose, stevia, thaumatin, salts, derivatives, and combinations thereof. A preferred high intensity sweetener according to the present invention is sucralose.

[00023] Cohesive non-free flowing sweetener compositions of the present invention may contain from about 0.01%(wt) to about 3.5%(wt) of a high intensity sweetener. More preferably, cohesive non-free flowing sweetener compositions of the present invention may contain from about 0.05%(wt) to about 2%(wt), even more preferably from about 0.1%(wt) to about 1%(wt) of a high intensity sweetener based on the weight of the cohesive non-free flowing sweetener composition.

[00024] If the only high intensity sweetener used is sucralose, the cohesive non-free flowing sweetener compositions of the present invention preferably contain from about 0.1%(wt) to about 0.6%(wt) of sucralose. More preferably, such a cohesive non-free flowing sweetener composition of the present invention contains from about 0.2%(wt) to about 0.5%(wt), even more preferably from about 0.4%(wt) to about 0.5%(wt) of sucralose based on the weight of the cohesive non-free flowing sweetener composition.

Bulking Agents

[00025] To further reduce the caloric burden of the cohesive non-free flowing sweetener compositions, the sucrose must be replaced in whole or in part by lower calorie ingredients. However, the use of ingredients other than sucrose may present problems with regard to production, storage, and consumer appeal and acceptance. In the present invention, bulking agents are used to replace some or all of the sucrose.

[00026] The specific bulking agent(s) are selected to produce sweetener cubes from the cohesive non-free flowing sweetener composition with physical and sensory characteristics similar to those of a sucrose cube. Such sweetener cubes may contain specific bulking agents that have physical and sensory properties similar to sucrose or may contain a combination of bulking agents that individually do not, but when combined do, have characteristics similar to sucrose. Numerous factors must be considered in the selection of bulking agents for use in the present invention.

[00027] First, the bulking agent generally has a sweetness intensity well below that of sucrose, so the addition of a high intensity sweetener is required to produce a sweetener cube from the cohesive non-free flowing sweetener composition that has a level of sweetness acceptable to consumers. The amount of high intensity sweetener used in such a sweetener cube is inversely related to the native sweetness of the bulking agent. Care must be taken to properly balance the ingredients to produce the sweetness expected by the consumer that is approximately equal to the sweetness of a sucrose-containing sweetener cube, e.g., one teaspoon of sucrose.

[00028] As used herein, the term "teaspoon" refers to a standard teaspoon, which has a volume of about 5 milliliters. Accordingly, a teaspoon of sucrose has a mass of about 4 to about 5 grams.

[00029] Second, bulking agent(s) must be selected that are acceptable to consumers in roughly five areas: appearance, taste, side effects, use, and cost. With regard to appearance, the sweetener cubes from the cohesive non-free flowing sweetener composition should mirror its sucrose equivalent as much as possible. The cohesive non-free flowing sweetener composition should appear crystalline. And, the cohesive non-free flowing sweetener composition should maintain its shape during storage and transport. For example, proteins will often have non-crystalline appearance and some sugars have yellow or sallow color. Neither will produce an acceptable sweetening cube when used in isolation as a bulking agent. Moreover, some possible bulking agents are far too hygroscopic to maintain cube integrity and shape for any length of time when used in isolation. For example, soluble fibers may absorb so much water from the environment that the cohesive non-free flowing sweetener compositions will begin to dissolve into a syrup that is undesirable to, and often unusable by consumers.

[00030] As used herein, the term "bulking agent" means a food grade substance that may be used to produce a cohesive non-free flowing sweetener composition with sensory and physical characteristics similar to that of a conventional sucrose cube. Examples of bulking agents for use in the present invention include mono- and disaccharides, such as, glucose, allose, altrose, mannose, idose, galactose, talose, ribose, arabinose, xylose, lyxose, cellobiose, gentiobiose, isomaltose, lactose, laminarabinose, maltose, amylose, mannobiose, xylobiose, sucrose, trehalose, cellobiose, lactulose, fructose, tagatose, lactitol; aerated sugars, aerated polyols, and aerated complex carbohydrates; oligosaccharides and polysaccharides, such as, cyclodextrins, raffinose, cellulose, inulin, gum arabic, nutriose, maltodextrin, fibrisol,

raftiline, raftilose; polyols, such as, isomalt, lactitol, maltitol, xylitol, erythritol, mannitol, sorbitol; soluble fiber; protein; calcium citrate; and calcium lactate and combinations thereof. A preferred bulking agent according to the present invention is erythritol.

[00031] As used herein, a "food-grade" material is one that conforms to the standards for foods deemed safe for human consumption set forth in the Codex Alimentarius produced by the World Health Organization (1999).

[00032] Preferably, the cohesive non-free flowing sweetener compositions of the present invention contain from about 1%(wt) to about 99.5%(wt) of a bulking agent. More preferably, the cohesive non-free flowing sweetener compositions of the present invention contain from about 10%(wt) to about 75%(wt), even more preferably about 30%(wt) to about 60%(wt) of a bulking agent.

[00033] As used herein, the term "bulking agent with a negative heat of solution" means a food grade substance that may be used to produce a cohesive non-free flowing sweetener composition with sensory and physical characteristics similar to that of a conventional sucrose cube that draws heat from the surroundings when dissolved in water. Examples of bulking agents for use in the present invention include mono- and disaccharides, such as, glucose, allose, altrose, mannose, idose, galactose, talose, ribose, arabinose, xylose, lyxose, cellobiose, gentiobiose, isomaltose, lactose, laminarabinose, maltose, amylose, mannobiose, xylobiose, cellobiose, lactulose, fructose, tagatose, lactitol; aerated sugars, aerated polyols, and aerated complex carbohydrates; polyols, such as, isomalt, lactitol, maltitol, xylitol, erythritol, mannitol, sorbitol; and combinations thereof. A preferred bulking agent with a negative heat of solution according to the present invention is erythritol.

[00034] Preferably, the cohesive non-free flowing sweetener compositions of the present invention contain from about 1%(wt) to about 99.5%(wt) of a bulking agent with a negative heat of solution. More preferably, the cohesive non-free flowing sweetener compositions of the present invention contain from about 10%(wt) to about 75%(wt), even more preferably about 30%(wt) to about 60%(wt) of a bulking agent with a negative heat of solution.

The heat of solution of a compound is a measure of the amount of energy taken from or the amount of energy released into the surroundings when the compound is dissolved in water. A compound that draws heat from the surroundings upon dissolution has a negative heat of solution. A compound that releases heat into the surroundings upon dissolution has a positive heat of solution. Accordingly, bulking agents with negative heats of solution will draw energy from the surroundings when the sweetener cube is dissolved.

[00035] As used herein the term “compound having a positive heat of solution” means a food-grade material that has a positive heat of solution in water. Thus, the compounds with positive heats of solution of the present invention will release heat into the foodstuff in which the sweetener cube is dissolved. Examples of compounds with positive heats of solution for use in the present invention include polydextrose, maltodextrin, trehalose, inulin, glycerine, and combinations thereof. Preferably, the compound having a positive heat of solution is a combination of polydextrose and trehalose. Preferably, the compound having a positive heat of solution is present in the sweetener cube in an amount from about 1%(wt) to about 50%(wt), more preferably from about 4%(wt) to about 30%(wt), even more preferably about 20%(wt).

[00036] The magnitude of the negative heat of solution of a composition is directly proportional to the cooling sensation that will be produced upon consumption of the composition. So the lower the total heat of solution of a cohesive non-free flowing sweetener composition, the greater the cooling the effect.

[00037] A cooling effect is much more readily detected when a cohesive non-free flowing sweetener composition is eaten directly. Because the cohesive non-free flowing sweetener composition is dissolved directly on the surface of the tongue and mouth, the energy needed to dissolve the cohesive non-free flowing sweetener composition is drawn directly from the surface of the tongue and mouth. Thus, a small negative heat of solution is easily detected on these sensitive areas.

[00038] When a cohesive non-free flowing sweetener composition is dissolved in a hot beverage, e.g., coffee or hot chocolate, the cooling effect is much less prevalent because the energy required to dissolve the cohesive non-free flowing sweetener composition is drawn from the coffee. This large volume of a high heat capacity substance (water) disperses and dilutes the cooling effect. For example, a 1.4 gram sweetener cube made of the cohesive non-free flowing sweetener composition of the present invention containing 90% by weight erythritol (-42.9 kilocalories per gram) will have a total heat of solution of about -54 kilocalories. When dissolved in about a 70 milliliter cup of coffee, such a sweetener cube lowers the overall temperature of the coffee by about 0.75 degrees. While not a large change in the temperature of the beverage, this change is detectable by consumers and the cooling effect may be further enhanced by bulking agents with cooling flavors.

Producing Cohesive Non-free Flowing Sweetener Compositions

[00039] Cohesive non-free flowing sweetener compositions are generally produced by a process having the following steps: (a) blending the ingredients, (b) forming a shaped composition, and (c) drying the composition. Obviously, each step may have a number of variations.

[00040] A further embodiment of the present invention is a method of making a sweetener cube from a cohesive non-free flowing sweetener composition including the steps of a) selecting a high intensity sweetener and a bulking agent with a negative heat of solution so that the total heat of solution of the sweetener cube made therefrom is between about 5 kilocalories and about -20 kilocalories; b) combining the components selected in step (a) to

form a blend; c) adding water to the blend; d) forming the blend into a cube shape; and e) drying the cube shape.

[00041] An additional embodiment of the present invention is a method of making a sweetener cube from a cohesive non-free flowing sweetener composition including the steps of a) selecting a high intensity sweetener, a bulking agent, and a compound with a positive heat of solution so that the total heat of solution of the sweetener cube made therefrom is between about 5 kilocalories and about -20 kilocalories; b) combining the components selected in step (a) to form a blend; c) adding water to the blend; d) forming the blend into a shape; and e) drying the shape.

[00042] While the manner in which the ingredients are blended is not critical, overly aggressive blending may result in an undesirable particle size reduction. It is, however, imperative to have a uniform distribution of the ingredients throughout the blend. Otherwise, both the sweetness and the caloric burden will vary from shape to shape. For ingredients used in small amounts it may be necessary to produce a pre-blend to ensure even distribution. If an ingredient tends to cake or lump, it may need to be passed through a sieve. The most common blenders are those that allow for continuous addition of ingredients.

[00043] Forming a shaped cohesive non-free flowing sweetener composition generally has two phases. First, the blended ingredients are hydrated to a moisture content from about 0.3% to about 3%, usually by the introduction of water or steam. Second, the hydrated ingredients are placed into dyes or molds and compressed to form the desired shape. The hydrated mixture may also be formed into large blocks and later broken into "rough cut" shapes.

[00044] Once the hydrated mixture has been formed into the desired shape it is dried. Drying may be accomplished using ovens or, if conditions permit, by exposure to ambient air. The most common dryers are continuous bands passing through a drying tunnel. Drying temperatures and times vary considerably. For example, in ambient air the drying time may be about 24 hours. In contrast, drying in an oven at about 60°C to about 75°C can take as little as about 10 to about 20 minutes. A conditioning step may also be required after oven or air-drying of approximately about 12 to about 36 hours to allow moisture to equilibrate throughout the products.

[00045] The shape of the mold chosen to form the cohesive non-free flowing sweetener composition determines the overall shape of the cohesive non-free flowing sweetener composition. Any desired shape can be used, including, cube, ball, pyramid, and the like. Additionally, the surface of the cohesive non-free flowing sweetener composition may modified to introduce a feature. A surface feature may be imparted by the surface of the mold used to form the cohesive non-free flowing sweetener composition or the dried cohesive non-free flowing sweetener composition may be further processed to produce the desired surface feature. In addition, the cohesive non-free flowing sweetener composition may also be shaped when still damp to introduce surface features or to produce novel shapes. For example, the dried cohesive non-free flowing sweetener composition may be laser or mechanically etched, or the desired feature may be burned into the surface of the cohesive non-free flowing sweetener composition using a heated tool. Once dry, the cohesive non-free flowing sweetener composition is then packed into tubs, boxes or other food appropriate packaging prior to consumer use.

[00046] The shapes and surface features of the cohesive non-free flowing sweetener compositions of the present invention may be introduced in two ways. First, the dyes or molds used to form a shaped cohesive non-free flowing sweetener composition may be contoured to produce the novel shapes or surface features during the shape formation. Second, after drying, the shaped cohesive non-free flowing sweetener composition may be cut or milled to produce the desired shape or surface feature.

[00047] Cohesive non-free flowing sweetener compositions of the present invention may be of any size convenient for manufacture and acceptable for use by a consumer. Cubes formed of the cohesive non-free flowing sweetener compositions are generally less than about 20 millimeters in height, less than about 20 millimeters in width, and less than about 20 millimeters in depth. Other useful sizes include about 12 millimeters in height, about 12 millimeters in width, and about 9 millimeters in depth, and even more preferably about 9 millimeters in height, about 9 millimeters in width, and about 9 millimeters in depth.

[00048] Another embodiment of the present invention is a low-calorie sweetener cube made according to one of the processes described herein.

Consumer Preferences

[00049] A conventional sucrose cube is the standard to which all other sweetening cube products are compared. Any sweetening cube product that deviates significantly from the physical and sensory characteristics of a conventional sucrose cube is not likely to be acceptable to the consumer. Table 1 shows physical and sensory characteristics of sucrose cubes and acceptable ranges for other sweetening cube products.

Characteristic	Sucrose cube	Acceptable range
Appearance	White, crystalline	Color from white to pale cream, crystalline
Taste	Sweet, syrupy	Delivery of sweetness, no other strong flavor notes (i.e. any additional flavors must not be stronger than the sweetness)
Undesirable effects	None	Minimal negative consumer related claims such as laxative effect
Stability	Maintains shape during storage and transport	Maintains cube shape during processing and transport up to 75% RH
Solubility	Approx. 30 seconds in hot water (85°C)	Cube dissolves in hot water (150ml at 85°C) in about 10 to about 60 seconds with agitation
Friability	Maintains integrity on handling	Less than 10% weight loss from dry cube when agitated for 60 seconds
Hardness	4000g pressure (bench made), 25,000 machine made (texture analyzer)	1,000 – 15,000g for laboratory made samples, up to 30,000g for pilot scale / commercially made samples
Particulate size range	0 – 2 millimeters	0 – 3 millimeters for overall blend of ingredients used to make up the cube

Table 1. Physical and sensory characteristics of sucrose cubes and acceptable ranges for other sweetening cube products.

[00050] To be accepted by a consumer as an acceptable substitute for a conventional sucrose cube, a cohesive non-free flowing sweetener composition of the present invention must have enough sensory and physical characteristics within the acceptable ranges shown in Table 1. Every characteristic of the sweetener cube formed from the cohesive non-free flowing sweetener composition need not fall within the ranges in Table 1 for the sweetener cube to be acceptable to a consumer. For example, a sweetener cube of the present invention intended to replace a brown sugar cube would have a brown color, and therefore, would not fall with the acceptable range for "appearance" in Table 1, but would still be acceptable to a consumer.

[00051] With regard to taste, a sweetener cube formed from a cohesive non-free flowing sweetener composition of the present invention should give a sweetness level equivalent to a similar weight of sucrose cube, and deliver a sweetness profile similar to sucrose. With regard to side effects, the bulking agent must not produce undesirable or unexpected side effects for the consumer. For example, some sugar alcohols may have a laxative effect on the consumer. Unless this is a desired effect, a cohesive non-free flowing sweetener composition employing such sugar alcohols would not find consumer acceptance.

[00052] The cohesive non-free flowing sweetener compositions must also function as expected by the consumer and quickly dissolve to produce the desired sweetness in the foodstuff. For example, the bulking agent may have a low solubility in water, and therefore, the cohesive non-free flowing sweetener composition may dissolve too slowly for the consumer or may not dissolve completely. As noted above, the production of cohesive non-free flowing sweetener compositions with desirable consumer characteristics may be achieved either by the use of a single bulking agent with the desired characteristics or by the use of a combination bulking agents that together produce the desired characteristics.

[00053] With regard to cost, the cohesive non-free flowing sweetener compositions should be of acceptable cost to the consumer when compared with other sweetening formats, such as tablets, sucrose cubes, sucrose, high intensity sweeteners, and granular sweeteners. For example, erythritol may be sourced commercially in a white crystalline format of good particulate size similar to sucrose, but may be comparatively expensive; therefore this may be combined with a less expensive bulking agent such as maltose and still provide the required overall characteristics.

[00054] Overlapping with the above considerations are various bulking agent characteristics that affect the production and/or storage and transport of cohesive non-free flowing sweetener compositions. These characteristics include: caloric burden, friability, dissolution, heat of solution, hardness, rigidity, moisture uptake, effect of humidity, and effect of temperature. Processing considerations include ease of raw material storage and processing and ease of flow of mixture for consistent and accurate fill of molds. Table 2 lists various ingredients and factors that must be considered in screening for the proper bulking agent(s) useful in a cohesive non-free flowing sweetener compositions of the present invention.

Ingredient			kcal / g	Screening Factors	
Class	Subclass	Examples		Negatives	Positives
Protein			4.0	Non-crystal appearance	
Carbohydrates	Sugars	Sucrose	4.0	Consumer negative	
		Fructose	4.0	Hygroscopic	
		Lactose	4.0	Mostly Small particulates	Low cost
		Galactose	4.0	High cost	
		Maltose	4.0		Low cost, Crystalline
		Trehalose	4.0		Excellent appearance
		Tagatose	1.5		Crystalline, Low calorie
	Sugar alcohols	Mannitol	1.6	Laxative effect	
		Sorbitol	2.6	Laxative effect	
		Xylitol	2.4	Laxative effect	
		Erythritol	0.2	Negative heat of solution	
	Complex Carbohydrates	Maltodextrin	4.0	Non crystalline	Low cost bulking Glue effect
		Polydextrose	1.0	Non crystalline	Glue effect
		Soluble Fiber	1.0 - 2.0	Hygroscopic, Laxative	
Minerals		Ca citrate	2.0		Powdery, Possible bulk
		Ca lactate	2.0		Powdery, Possible bulk

Table 2. Potential bulking agents.

[00055] Even if an ingredient is appropriate for use as a bulking agent, the proportion of the ingredient used in the cohesive non-free flowing sweetener composition may have significant effects on the characteristics of the composition. For example, Figure 1 shows the caloric burden as a function of ingredient content for various potential bulking agents. An increase in the maltose or maltodextrin compared to the reference blend increases the caloric burden. In contrast, increases in the proportion of the other ingredients results in a reduction of the caloric burden.

[00056] Many bulking agents have negative heats of solution which are considerably larger than that of sucrose. Table 3 lists sucrose and various bulking agents and their heats of solution.

Bulking Agent	**Heat of Solution (KCal/g)**
Glycerine	+9.0
Polydextrose	+8.0
Inulin	+4.0 to +8.0
Trehalose	+4.9
Maltodextrin	0.0
Sucrose	-4.3
Maltitol	-5.5
Maltose	-8.0
Isomalt	-9.4
Lactitol	-13.9
Lactose	-15.5
Sorbitol	-26.5
Mannitol	-28.9
Xylitol	-36.6
Erythritol	-42.9

Table 3. Heats of solution for sucrose and various bulking agents.

[00059] A sweetener cube made from a cohesive non-free flowing sweetener composition containing one of these negative heat of solution bulking agents will draw heat from the foodstuff as it goes into solution, e.g., cooling the beverage. If this cooling effect is large enough, the consumer will detect it. This is particularly relevant in markets where beverage consumption after a meal is in the form of a low volume (typically from 70 – 100ml) highly flavored drink, such as coffee, often accompanied by up to 2 teaspoons of Sucrose Equivalent Sweetness. Such cooling is typically not expected or desired by the consumer, especially in a hot beverage, such as coffee. Accordingly, it is desirable to have a heat of solution as close to 0 as possible.

[00060] As used herein, a gram (or other given amount) of "Sucrose Equivalent Sweetness" means the amount of high intensity sweetener needed to be added to an 8 ounce glass of water in order to provide the same sweetness as an independent 8 ounce glass of water containing 1 gram (or the other given amount) of sucrose. For example, 1/200 gram of aspartame will equal about 1 gram of Sucrose Equivalent Sweetness because aspartame is about 200 times sweeter than sucrose. Similarly, about 1/500 gram to about 1/600 gram of sucralose will provide one gram of Sucrose Equivalent Sweetness because sucralose is about 500 to about 600 times sweeter than sucrose

[00061] The heat of solution of sucrose is about -4.3 kilocalories per gram or about -21.5 kilocalories for a 5 gram sucrose cube and about -6 kilocalories for a 1.4 gram reduced calorie conventional sucrose cube containing a high intensity sweetener. Most consumers are likely to detect the cooling effect of the dissolution of a sweetener cube having a total heat of solution of less than about -20 kilocalories. A highly sensitive consumer, however, is likely to detect the cooling affect of the dissolution (in a hot cup of coffee) of a sweetener cube having a total heat of solution of between about -13 kilocalories and about -20 kilocalories.

[00062] Moreover, when the low-calorie product is eaten as a cube directly by the consumer without prior dissolution in a beverage, the consumer will be even more likely to detect the cooling effect with a cohesive non-free flowing sweetener composition having a very low total heat of solution, i.e., between -13 and -20 kilocalorie per gram.

[00063] In the present invention, "total heat of solution" means the aggregate heats of solution of all compounds in the sweetener cube.

[00064] To counteract this cooling affect, a compound with a positive heat of solution is added to the sweetener cube made of a cohesive non-free flowing sweetener composition in sufficient quantity to bring the total heat of solution to above about -20 kilocalories per sweetener cube, preferably above about -13 kilocalories per sweetener cube, such as for example from about +5 to about -13 kilocalories per sweetener cube.

[00065] Another embodiment of the present invention is a low-calorie sweetener cube made according to one of the processes described herein.

[00066] Sweetener cubes of the present invention may be of any size convenient for manufacture and acceptable for use by a consumer. Preferably the sweetener cubes are less than about 20 millimeters in height, less than about 20 millimeters in width, and less than about 20 millimeters in depth. More preferably, the sweetener cubes are about 12 millimeters in height, about 12 millimeters in width, and about 9 millimeters in depth, and even more preferably about 9 millimeters in height, about 9 millimeters in width, and about 9 millimeters in depth.

[00067] The following examples are provided to further illustrate the compositions and methods of the present invention. These examples are illustrative only and are not intended to limit the scope of the invention in any way.

EXAMPLES

Example 1

[00068] The cohesive non-free flowing sweetener compositions of the present invention may be made in any manner known in the art. Described below are two methods for producing cohesive non-free flowing sweetener compositions of the present invention: A) a laboratory scale preparation method and B) a larger production scale preparation method.

A. Laboratory Scale Preparation Method

[00069] All ingredients are weighed. The weighed ingredients are placed into a glass jar and blended in a tubular mixer for five minutes. The blended ingredients are then spread as thinly as possible along a flat surface to achieve a layer as close to a one particle thick as possible.

[00070] A short burst of water is then sprayed across the layer of blended ingredients with an aerosol pump. The desired amount of water may be measured before addition into the aerosol pump. (For granulated sugar, for example, water added is typically about 3.5

milliliters per 100 grams of sugar.) The blended ingredients are then mixed with a pallet knife.

[00071] To determine if enough water has been added, some of the blended ingredients are placed into a cube mold. Using the appropriate stamp, as much of the blended ingredients as possible are compacted into the mold, adding compression on both sides to increase pressure. Once the mold is full the stamp is used to push out the blended ingredients.

[00072] If the composition breaks immediately and granules disperse, there is not enough moisture. The blended ingredients are then spread, sprayed with additional water, and mixed again with the pallet knife. The blended ingredients are then re-evaluated for water content.

[00073] On the other hand, if clumps are present and part of the composition remains in the mold, too much moisture has been added to the blended ingredients. In this case, the blended ingredients must be discarded and the process restarted from the beginning.

[00074] Once an appropriate amount of water has been added, the blended ingredients are compressed in molds. The molded compositions are then placed onto a tray and dried at 70°C in an oven. One cube is broken in half about every 10 minutes to assess breakability due to moisture content. Once the water has been removed from the cubes they should be hard throughout. The drying should take about 10 to about 30 minutes. If further drying is desired, the cubes may be placed in a 30°C room overnight.

B. Production Scale Preparation Method

[00075] All ingredients are weighed and blended to uniformity. The blended ingredients are then transferred to a powder hopper above a cube machine (Type C Cube Machine, Teknikeller, Ankara, Turkey). The blended ingredients are added to the mixing chamber of the cube machine and mixed with water. The amount of water is adjusted to ensure good distribution of water throughout the blended ingredients. Insufficient water will

produce deposits of powder on the extraction belt used to transport cubes to the oven and result in friable cubes. Over-wetting the blended ingredients will produce visibly wet cubes, the cubes will be hard, but will have lost the sparkle associated with the glassy surface of individual crystals in conventional sucrose cubes. Target blend moisture content is about 0.5% to about 1.0%, depending on cube appearance.

[00076] The wet blended ingredients then fall by gravity from the belt into a rotating mold. Pistons compress the cubes to the required dimensions. The mass of the cubes may be adjusted by tightening the compression plate or by altering the amount of travel of the pistons. The pistons push out the formed cube onto the extraction belt, and a pushing arm pushes the cubes onto a chain conveyor to pass the cubes into the drying oven.

[00077] The shape of the mold chosen to form the cohesive non-free flowing composition determines the overall shape of the composition. Using the appropriate mold any of the shapes disclosed herein may be formed.

[00078] The cubes may then be dried in a static oven or by using a conveying (tunnel) oven. Temperatures should not exceed 70oC for 10 to 30 minutes. The cubes may need to be "tempered" prior to packing and should cool from the drying temperature to room temperature prior to packing to avoid accumulation of condensation inside the packaging.

[00079] As discussed above the cubes may be further processed to introduce a surface feature onto the surface of the cube.

[00080] The sweetener cubes of the following examples may be formed using either of the two methods above.

[00081] Example 1

[00082] Shaped cohesive non-free flowing sweetener compositions of the present invention having the ingredients in Table 4 are produced using the laboratory scale preparation method described above Example 1.A.

Formulation Number	Polydextrose (% wt)	Tagatose (% wt)	Erythritol (% wt)	Trehalose (% wt)	Maltodextrin (% wt)	Maltose (% wt)	Sucralose (% wt)	KCal/ Cube
1	9.9	26.6	10.9	-	7.7	45.0	-	3.67
2	9.9	26.6	10.9	45.0	7.7	-	-	3.67
3	5.4	24.3	25.8	-	13.1	31.5	-	3.15
4	5.4	24.3	25.8	31.5	13.1	-	-	3.15
5	8.2	28.9	36.7	26.3	-	-	-	2.29
6	-	36.8	10.8	15.0	-	37.0	-	3.74
7	9.6	33.0	-	15.0	-	42.0	0.4	4.04
8	10.0	-	29.5	15.0	-	45.1	0.4	3.61
9	10.0	37.5	28.4	11.2	2.5	10.0	0.4	2.36
10	9.9	26.6	10.9	35.0	7.7	10.0	-	3.67
11	9.9	26.6	10.9	30.0	7.7	15.0	-	3.67
12	9.9	26.6	10.9	25.0	7.7	20.0	-	3.67
13	9.9	26.6	10.9	20.0	7.7	25.0	-	3.67
14	9.9	26.6	10.9	15.0	7.7	30.0	-	3.67
15	9.9	26.6	10.9	10.0	7.7	35.0	-	3.67
16	10.0	-	37.5	40.7	11.8	-	-	3.18
17	10.0	68.0	-	-	-	21.5	0.5	2.80
18	8.2	28.9	36.7	15.0	-	10.7		2.29
19	5.4	24.3	25.8	15.0	13.1	15.9	0.5	3.15
20	-	99.6	-	-	-	-	0.4	2.10
21	10.0	-	37.5	52.1	-	-	0.4	3.18
22	-	42.6	-	57.0	-	-	0.4	4.04
23	-	32.8	41.0	13.0	-	12.7	0.5	2.29
24	-	29.6	25.8	31.5	13.1	-	-	3.15
25	10.0	37.5	28.4	23.7	-	-	0.4	2.33
26	10.0	-	56.6	33.0	-	-	0.4	1.53

Table 4. Composition and caloric burden of shaped cohesive non-free flowing sweetener compositions of the present invention.

[00083] The shaped cohesive non-free flowing sweetener compositions produced above are subjected to testing for various properties.

[00084] Sucrose has a white, highly crystalline appearance. It is desirable for a shaped cohesive non-free flowing sweetener composition to have an appearance as close to a conventional sucrose cube as possible. The crystal appearance of each of the shaped cohesive non-free flowing sweetener compositions was assessed against commercially available TUTTI FREE™ (Saint Louis Sucre, Paris, France) cubes containing about 1.4 grams of sucrose. The crystal appearance of the experimental cubes was assessed on a scale of 1 to 5 by a panel of 3 to 4 people familiar with the TUTTI FREE™ product. A score of 5

represents a shaped cohesive non-free flowing sweetener composition with a crystal appearance that is virtually indistinguishable from that of the TUTTI FREE™ product and a score of 1 represents a shaped cohesive non-free flowing sweetener composition that displays virtually no crystal characteristics whatsoever.

[00085] Table 5 shows crystal appearance at 0%, 50% and 75% relative humidity for various formulations. These relative humidities represent a control (0%), the typical relative humidity found in consumers' homes (50%), and maximum expected under normal conditions (75%).

Formulation Number	Crystal Appearance		
	0% Relative Humidity	50% Relative Humidity	75% Relative Humidity
1	2.0	2.5	2.5
2	3.5	3.0	3.0
3	3.5	2.5	4.0
4	4.0	4.0	4.0
5	4.0	4.0	4.0
6	4.0	4.0	4.0
7	3.5	2.0	4.0
8	3.5	2.0	4.0
9	3.5	3.5	3.5
10	2.5	2.5	3.0
11	3.0	2.5	2.5
12	3.0	2.5	3.5
13	2.0	2.0	2.5
14	4.0	3.0	3.5
15	3.5	2.0	2.5
16	2.5	2.0	3.0
17	4.0	4.0	4.0
18	4.0	4.0	4.0
19	3.5	3.5	3.5
20	3.0	3.0	3.0
21	3.5	3.5	3.5
22	3.0	3.0	3.0
23	3.5	3.5	3.5
24	3.5	3.5	3.5
25	3.5	3.5	3.0
26	4.0	4.0	3.5

Table 5. Crystal appearance at 0%, 50%, and 75% relative humidity.

[00086] A crystalline appearance below about 4 will not be acceptable to a consumer as a substitute for a conventional sucrose cube.

[00087] A conventional sucrose cube has a friability of less than about 5%. To determine the friability of the experimental shaped cohesive non-free flowing sweetener compositions, each shaped cohesive non-free flowing sweetener composition is placed on a 1-millimeter mesh. The shaped cohesive non-free flowing sweetener composition is then gently brushed with a 2-inch brush to remove any loose powder. The shaped cohesive non-free flowing sweetener composition is weighed to four decimal places. The shaped cohesive non-free flowing sweetener composition is placed in the drum of a Caleva friability tester (Caleva Process Solutions Ltd, Dorset, United Kingdom) and rotated for 10 revolutions. The shaped cohesive non-free flowing sweetener composition is again placed on the mesh and gently brushed to remove any loose powder. The shaped cohesive non-free flowing sweetener composition is then re-weighed to four decimal places. The change in mass is expressed as a percent weight lost for 10 revolutions.

[00088] Table 6 shows percent friability at 0%, 50% and 75% relative humidity for various formulations with ten revolutions.

Formulation Number	Friability %		
	0% Relative Humidity	50% Relative Humidity	75% Relative Humidity
1	16.72	11.76	0.46
2	32.31	3.66	0.19
3	10.16	27.15	0.14
4	5.62	5.24	11.87
5	12.61	9.61	0.26
6	10.74	8.43	0.07
7	16.00	51.6	0.29
8	12.67	13.2	0.21
9	1.90	7.75	0.18
10	3.30	4.26	0.26
11	3.67	6.55	24.0
12	3.17	8.38	11.0
13	3.86	7.43	36.0
14	4.38	2.45	31.0
15	2.63	8.64	24.0
16	3.51	17.49	53.0
17	3.90	2.52	0.45
18	9.33	8.43	0.07
19	4.62	6.31	0.11
20	3.19	3.32	1.21
21	9.84	4.55	0.21
22	3.85	8.50	2.10
23	6.27	12.50	4.78
24	2.33	2.90	0.32
25		1.43	0.15
26	16.72	0.31	0.17

Table 6. Percent friability at 0%, 50%, and 75% relative humidity.

[00089] If the friability of the shaped cohesive non-free flowing sweetener composition is greater than about 10% at a relative humidity of 50%, then the shaped cohesive non-free flowing sweetener compositions will crumble significantly upon transport to and use by the consumer. The consumer will not accept the loss of shape and mass by shaped cohesive non-free flowing sweetener compositions with a friability greater than about 10%.

[00090] The moisture content of each of the shaped cohesive non-free flowing sweetener compositions is determined using a moisture meter (MX-50 or MD-50, A&D Engineering, Inc., Milpitas, California). The moisture meter measures the percent weight lost by the shaped cohesive non-free flowing sweetener composition upon complete drying based on the total weight of the shaped cohesive non-free flowing sweetener composition. Table 7 shows moisture content at 0%, 50% and 75% relative humidity for various The moisture content of each of the shaped cohesive non-free flowing sweetener compositions is determined using a moisture meter (MX-50 or MD-50, A&D Engineering, Inc., Milpitas, California). The moisture meter measures the percent weight lost by the shaped cohesive non-free flowing sweetener composition upon complete drying based on the total weight of the shaped cohesive non-free flowing sweetener composition formulations.

Formulation Number	Moisture Content (%(wt))		
	0% Relative Humidity	50% Relative Humidity	75% Relative Humidity
1	2.98	3.02	3.10
2	3.84	3.88	0.66
3	2.06	4.34	1.76
4	2.41	3.43	1.60
5	1.53	2.28	4.03
6	2.90	3.69	3.76
7	5.07	5.30	4.90
8	3.86	6.35	4.02
9	1.90	2.05	1.71
10	3.30	3.94	3.01
11	3.67	3.92	2.01
12	3.17	3.36	2.01
13	3.86	4.36	2.60
14	4.38	3.11	1.77
15	2.63	3.75	1.95
16	3.51	3.75	2.10
17	1.83	2.61	2.17
18	2.23	2.71	2.68
19	2.30	3.67	2.13
20	1.44	1.39	1.70
21	3.46	7.19	5.11
22	1.89	4.77	5.26
23	3.49	3.50	2.94
24	4.46	2.24	4.98
25	2.53	3.63	2.10
26	2.20	4.01	4.54

Table 7. Moisture content at 0%, 50%, and 75% relative humidity.

[00091] If the moisture content of the cube is greater than about 3%, then the shaped cohesive non-free flowing sweetener compositions may become soft and friable, and may also adhere to each other. The consumer will not accept shaped cohesive non-free flowing sweetener composition with a moisture content greater than about 5% because they will be soft to handle, lack crunch on consumption, and will not be comparable to sucrose cubes that are familiar to consumers.

[00092] A conventional sucrose cube has a hardness of about 30,000 g and a rigidity of about 30,000 g/s. The hardness and rigidity for each of the experimental shaped cohesive non-free flowing sweetener compositions is determined using a TA-XT2i Texture Analyzer (Stable Micro Systems Ltd., Surrey, England). The shaped cohesive non-free flowing sweetener composition to be tested is placed horizontally on the testing platform of the analyzer, directly under a 1-inch diameter probe. The probe size ensures that compression occurs on flat edges to get an actual hardness value for the shaped cohesive non-free flowing sweetener composition. The analyzer settings are as follows:

Test Speed:	1 mm/s
Rupture Test Distance:	4 mm
Distance:	1 mm
Force:	100 g
Time:	5 sec
Load Cell:	50 Kg

[00093] Table 8 shows hardness at 0%, 50% and 75% relative humidity for various formulations.

Formulation Number	Hardness (g)		
	0% Relative Humidity	50% Relative Humidity	75% Relative Humidity
1	1824	1255	99
2	1179	496	1476
3	1615	438	1360
4	953	684	1142
5	1270	2783	2888
6	1981	1500	6300
7	2318	2949	5715
8	2927	1916	4304
9	779	2067	84
10	589	4228	627
11	2460	2833	538
12	188	690	176
13	2666	2097	509
14	934	2756	234
15	2228	1131	1054
16	776	872	2200
17	1606	1656	319
18	661	770	28
19	1651	1322	145
20	3465	690	426
21	4036	782	240
22	4295	1211	210
23	2752	649	1248
24	840	2482	129
25	3566	3092	83
26	2376	2725	1135

Table 8. Hardness at 0%, 50%, and 75% relative humidity.

[00094] If the hardness of the shaped cohesive non-free flowing sweetener composition is less than about 5000g, then the shaped cohesive non-free flowing sweetener composition will become friable and can be broken by manual pressure. The consumer will not accept shaped cohesive non-free flowing sweetener compositions with a hardness greater than about 30000g as these will dissolve too slowly in a beverage such as tea or coffee, i.e., much more slowly than a conventional sucrose cube.

[00095] Table 9 shows rigidity at 0%, 50% and 75% relative humidity for various formulations.

Formulation Number	Rigidity (g/s)		
	0% Relative Humidity	50% Relative Humidity	75% Relative Humidity
1	1797	1980	46
2	1265	1266	1466
3	1577	1578	1341
4	953	954	1106
5	1245	1246	2845
6	1977	1978	6252
7	2301	2302	5620
8	3077	3078	4263
9	8	2032	78
10	623	4167	613
11	2432	2804	533
12	176	670	167
13	3392	2074	494
14	911	2717	222
15	2548	1103	1037
16	766	842	2179
17	2762	2828	544
18	656	781	16
19	1610	1304	136
20	3400	667	496
21	3974	762	233
22	4983	1262	197
23	2754	619	1704
24	828	2558	118
25	3566	3053	74
26	2337	2682	1135

Table 9. Rigidity at 0%, 50%, and 75% relative humidity.

[00096] If the rigidity of the shaped cohesive non-free flowing sweetener composition is greater than about 10,000g/s, then the shaped cohesive non-free flowing sweetener compositions will become difficult to dissolve in liquid or crumble for use on foods. The consumer will not accept this slow dissolution of shaped cohesive non-free flowing sweetener compositions with a rigidity greater than about 30,000g/s.

[00097] Three to five panelists familiar with the TUTTI FREE™ (or reference cube) product determined the stickiness of each of the shaped cohesive non-free flowing sweetener compositions The panelists arrived at a value for the stickiness of the experimentalshaped cohesive non-free flowing sweetener compositions using the 0-5 scale of Table 10 by group discussion. On this scale, the TUTTI FREE™ product has a stickiness of 5.

Scale	Stickiness					
	5	4	3	2	1	0
Criteria	Cube; as control.	Cube; slightly soft.	Cube; tacky to the touch.	Cube; sticks to finger when lifted.	Cube; adhesive and forms a strand when removed.	Liquified.

Table 10. Stickiness assessment scale.

[00098] Table 11 shows stickiness at 0%, 50% and 75% relative humidity for various formulations.

Formulation Number	Stickiness		
	0% Relative Humidity	50% Relative Humidity	75% Relative Humidity
1	5	5	5
2	5	5	5
3	5	5	5
4	5	5	5
5	5	5	5
6	5	5	4
7	5	5	4
8	5	5	4
9	5	4.5	4
10	5	5	5
11	5	5	3
12	5	5	5
13	5	5	5
14	5	5	5
15	5	5	5
16	5	5	5
18	5	4	2
19	5	5	2
20	5	5	5
21	5	4	
22	5	5	5
23	5	5	5
24	5	5	2.5
25	5	5	3
26	5	5	4

Table 11. Stickiness at 0%, 50%, and 75% relative humidity.

[00099] Shaped cohesive non-free flowing sweetener compositions that have a stickiness less than about 3.5 at 50% relative humidity will adhere to one other and to any

surface that they contact. Such shaped cohesive non-free flowing sweetener compositions will not be convenient for or useable by the consumer.

[000100] A conventional sucrose cube has a dissolution time in water of about 5 to 20 seconds depending on cube size and water temperature. To determine the dissolution time of each of the experimental shaped cohesive non-free flowing sweetener compositions a 2-liter flask is filled with about 1 liter of water and placed on a magnetic stirring plate with heating plate. A 400-millimeter stirbar is placed in the flask. The water is heated to the desired temperature and stirred at about 150 to 180 rpm. A sieve with 1- or 1.18-millimeter mesh is placed mesh up, submerged in the water inside the flask above the stirring plate. The mesh is marked with an indelible marker for precise location of the cube. Using tweezers, the shaped cohesive non-free flowing sweetener composition to be tested is placed on the sieve using the indelible mark for precise placement. The time from submersion of the shaped cohesive non-free flowing sweetener composition and to complete dissolution is measured. The time of dissolution is recorded for 5 sweetener cubes of the same composition. The dissolution time is the average of the five individual dissolution times.

[000101] Table 12 shows dissolution time at 21°C, 55°C, and 85°C for various formulations. These temperatures represent the temperatures of hot beverages (85°C or 55°C) and room temperature (21°C).

Formulation Number	Dissolution Time (s)		
	85°C	55°C	21°C
1	45	13	195
2	43	12	290
3	117	18	300
4	97	44	230
5	16	28	40
6	44	27	300
7	32	31	215
8	20	43	127
9	15	14	98
10	6	31	23
11	32	42	153
12	19	16	108
13	37	23	127
14	8	42	42
15	38	39	78
16	10	18	300
17	45	47	147
18	14	35	84
19	20	98	73
20	8	24	68
21	27	27	97
22	23	24	154
23	53	25	300
24	46	257	285
25	25	21	56
26	19	65	320

Table 12. Dissolution time at 21°C, 55°C, and 85°C

[000102] Shaped cohesive non-free flowing sweetener compositions that have a dissolution time greater than about 60 seconds in a hot beverage (85oC) will not dissolve quickly enough to satisfy a consumer.

[000103] The total heat of solution for each of the shaped cohesive non-free flowing sweetener composition was calculated from the heats of solution and proportion of each ingredient. Table 14 shows the heat of solution for various formulations.

Formulation Number	Total Heat of Solution (K Cal)
1	-13.9
2	-13.9
3	-21.7
4	-21.7
5	-27.1
6	-16.7
7	-7.6
8	-21.1
9	-23.3
10	-13.9
11	-13.9
12	-13.9
13	-13.9
14	-13.9
15	-13.9
16	-25.7
17	-20.1
18	-27.1
19	-21.7
20	-14.0
21	-25.7
22	-7.6
23	<-30
24	-21.7
25	-21.5
26	-32

Table 14. Heats of solution.

[000104] As noted above, a consumer dissolving a shaped cohesive non-free flowing sweetener composition in a cup of coffee is not likely to detect any cooling effect if the shaped cohesive non-free flowing sweetener composition has a total heat of solution greater than about -13 kilocalories. A highly sensitive consumer is likely to detect the cooling affect of the dissolution (in a cup of coffee) of a shaped cohesive non-free flowing sweetener composition having a total heat of solution of between about -13 and about -20 kilocalorie. Consumers are likely to detect the cooling effect of the dissolution of a shaped cohesive non-free flowing sweetener composition having a total heat of solution of less than about –20 kilocalorie.

[000105] Based on these observations, a combination of polydextrose and trehalose has been found to be most effective at balancing the total heat of solution for a shaped cohesive non-free flowing sweetener composition containing a negative heat of solution bulking agent, such as erythritol.

[000106] A panel of 3 to 4 panelists tastes the 1.4 gram shaped cohesive non-free flowing sweetener composition of formulations 1-7 and a 1.4 gram sucrose cube. The panelists eat the compositions directly and in solution in 8 ounces of room temperature water. The cooling effect of each of the shaped cohesive non-free flowing sweetener compositions is assessed compared to the sucrose cube on a scale of 0 to 5 (5 = parity with sucrose through 0 = extreme cooling). Table 15 shows the heats of solution and cooling effect for a sucrose cube and various shaped cohesive non-free flowing sweetener compositions.

Formulation Number	Heat of Solution (KCal/cube)	Eaten	In Solution
1	-13.9	5.0	4.5
2	-13.9	5.0	5.0
3	-21.7	4.0	4.5
4	-21.7	3.5	4.0
5	-27.1	2.0	3.5
6	-16.7	4.0	4.0
7	-7.6	5.0	5.0
Sucrose	-5.0	5.0	5.0

Table 15. Heat of solution and cooling effect of a sucrose cube and various sweetener cubes.

[000107] Taste panel data from those formulas listed above indicates that in solution (hot or cold) a cooling affect is not significantly detected up to a total heat of solution of about 20 kilocalorie per shaped cohesive non-free flowing sweetener composition. When directly eaten detection level rises to about -13 kilocalorie per shaped cohesive non-free flowing sweetener composition. A small proportion of consumers, however, are particularly sensitive to this cooling effect and may be expected to detect is at higher heats of solution.

Example 3

[000108] Shaped cohesive non-free flowing sweetener composition of the present invention are made using the laboratory scale preparation method of Example 1.A. having a mass of containing the following ingredients:

0.4% sucralose,
10% polydextrose,
10% trehalose, and
30% erythritol.

[000109] These have a caloric burden of 14 kcal /g and a total heat of solution of -16.21 kilocalories per gram.

Example 4

[000110] Shaped cohesive non-free flowing sweetener composition of the present invention are made using the laboratory scale preparation method of Example 1.A. containing ingredients in the amounts show in Table 16.

Ingredient (% wt)							Caloric Burden (KCal/Cube)	Total Heat of Solution (K Cal/g)
Polydextrose	Tagatose	Erythritol	Trehalose	Maltodextrin	Maltose	Sucralose		
	99.6					0.4	2.09	-11.16
10.0	37.5	28.4	11.2	2.5	10.0	0.4	2.33	-20.18
	32.8	41	13		12.7	0.5	2.24	-28.36
10.0	37.5	28.4	23.7			0.4	2.33	-23.30
10.0	68.0				21.5	0.5	2.77	-6.50
5.4	24.3	25.8	15.0	13.1	15.9	0.5	3.12	-17.65
10.0		37.5	52.1			0.4	3.16	-21.46
9.6	33.0		15.0		42.0	0.4	4.02	-2.62
10.0		29.5	15.0		45.1	0.4	3.59	-16.64
	42.6		57.0			0.4	4.09	-4.77

Table 15. Composition, caloric burden, and total heat of solution of sweetener cubes of the present invention.

[000111] The scope of the present invention is not limited by the description, examples, and suggested uses herein and modifications can be made without departing from the spirit of the invention. Thus, it is intended that the present invention cover modifications and variations of this invention provided that they come within the scope of the appended claims and their equivalents. Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention pertains. All publications, patent applications, patents, and other references mentioned herein are incorporated reference in their entirety. In case of conflict, the present specification, including definitions, will control.

WHAT IS CLAIMED IS:

1. A cohesive non-free flowing sweetener composition comprising a high intensity sweetener and a bulking agent having a negative heat of solution in an amount sufficient to produce a total heat of solution in the cohesive non-free flowing sweetener composition of from about 5 kilocalories to about -20 kilocalories, wherein the cohesive non-free flowing sweetener composition has a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions.

2. A cohesive non-free flowing sweetener composition according to claim 1, wherein the total heat of solution of the cohesive non-free flowing sweetener composition is from about 5 kilocalories to about -13 kilocalories.

3. A cohesive non-free flowing sweetener composition according to claim 1, wherein the high intensity sweetener is selected from the group consisting of aspartame, acesulfame, alitame, brazzein, cyclamic acid, dihydrochalcones, extract of *Dioscorophyllum cumminsii,* extract of the fruit of *Pentadiplandra brazzeana*, glycyrrhizin, hernandulcin, monellin, mogroside, neotame, neohesperidin, saccharin, sucralose, stevia, thaumatin, their salts, and combinations thereof.

4. A cohesive non-free flowing sweetener composition according to claim 3, wherein the high intensity sweetener is sucralose.

5. A cohesive non-free flowing sweetener composition according to claim 1, wherein the bulking agent with a negative heat of solution is selected from the group consisting of glucose, allose, altrose, mannose, idose, galactose, talose, ribose, arabinose, xylose, lyxose, cellobiose, gentiobiose, isomaltose, lactose, laminarabinose, maltose, amylose, mannobiose, xylobiose, cellobiose, lactulose, fructose, tagatose, lactitol aerated sugars, aerated polyols, aerated complex carbohydrates, isomalt, lactitol, maltitol, xylitol, erythritol, mannitol, sorbitol, and combinations thereof.

6. A cohesive non-free flowing sweetener composition according to claim 5, wherein the bulking agent with a negative heat of solution is selected from the group consisting of maltose, tagatose, erythritol, lactose, and combinations thereof.

7. A cohesive non-free flowing sweetener composition containing about 0.5% sucralose, about 80% maltose, and about 20% erythritol by weight based on the total weight of the sweetener cube, wherein the cohesive non-free flowing sweetener composition has a total heat of solution from about 5 kilocalories to about -20 kilocalories, and a lower caloric burden and an equivalent sweetness to that of a conventional sucrose cube of the same dimensions.

8. A cohesive non-free flowing sweetener composition comprising a high intensity sweetener, a bulking agent, and a compound with a positive heat of solution in an amount sufficient to produce a total heat of solution in the sweetener cube of from about 5 kilocalories to about -20 kilocalories, wherein the cohesive non-free flowing sweetener composition has a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions.

9. A cohesive non-free flowing sweetener composition according to claim 8, wherein the total heat of solution of the cohesive non-free flowing sweetener composition is between about 5 kilocalories and -13 kilocalories.

10. A cohesive non-free flowing sweetener composition according to claim 8, wherein the compound with a positive heat of solution is selected from the group consisting of polydextrose, maltodextrin, trehalose, inulin, glycerine, and combinations thereof.

11. A cohesive non-free flowing sweetener composition according to claim 10, wherein the compound with a positive heat of solution is selected from the group consisting of polydextrose, trehalose, and combinations thereof.

12. A cohesive non-free flowing sweetener composition according to claim 8, wherein the high intensity sweetener is selected from the group consisting of aspartame, acesulfame, alitame, brazzein, cyclamic acid, dihydrochalcones, extract of *Dioscorophyllum cumminsii*, extract of the fruit of *Pentadiplandra brazzeana*, glycyrrhizin, hernandulcin, monellin, mogroside, neotame, neohesperidin, saccharin, sucralose, stevia, thaumatin, their salts, and combinations thereof.

13. A cohesive non-free flowing sweetener composition according to claim 12, wherein the high intensity sweetener is sucralose.

14. A cohesive non-free flowing sweetener composition according to claim 8, wherein the bulking agent is selected from the group consisting of glucose, allose, altrose, mannose, idose, galactose, talose, ribose, arabinose, xylose, lyxose, cellobiose, gentiobiose, isomaltose, lactose, laminarabinose, maltose, amylose, mannobiose, xylobiose, cellobiose, lactulose, fructose, tagatose, lactitol, aerated sugars, aerated polyols, aerated complex carbohydrates, cyclodextrins, raffinose, cellulose, inulin, gum arabic, nutriose, fibrisol, raftiline, raftilose, isomalt, lactitol, maltitol, xylitol, erythritol, mannitol, sorbitol, soluble fiber, protein, calcium citrate, calcium lactate, and combinations thereof.

15. A cohesive non-free flowing sweetener composition according to claim 14, wherein the bulking agent is selected from the group consisting of maltose, tagatose, erythritol, and combinations thereof.

16. A cohesive non-free flowing sweetener composition comprising about 0.3% to about 0.6% sucralose, about 10% to about 60% erythritol, about 4% to about 10% polydextrose, and about 10% to about 60% trehalose by weight based on the total weight of the cohesive non-free flowing sweetener composition, wherein the cohesive non-free flowing sweetener composition has a total heat of solution between about 5 kilocalories and about -20

kilocalories, and a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions.

17. A cohesive non-free flowing sweetener composition comprising about 0.4% sucralose, about 10% polydextrose, about 40% trehalose, and about 49.6% erythritol by weight based on the total weight of the sweetener cube, wherein the sweetener cube has a total heat of solution between about 5 kilocalories and about -13 kilocalories, and a lower caloric burden and an equivalent sweetness compared to that of a conventional sucrose cube of the same dimensions.

18. A method of making a cohesive non-free flowing sweetener composition comprising:

a) selecting a high intensity sweetener and a bulking agent with a negative heat of solution so that the total heat of solution of the cohesive non-free flowing sweetener composition made therefrom is from about 5 kilocalories to about -20 kilocalories;

b) combining the components selected in step (a) to form a blend;

c) adding water to the blend;

d) forming the blend into a shape; and

e) drying the shape.

19. A method according to claim 18, wherein the high intensity sweetener is sucralose, which is present in the cohesive non-free flowing sweetener composition in an amount of about 0.5% by weight based on the total weight of the cohesive non-free flowing sweetener composition and the bulking agent with a negative heat of solution comprises maltose and erythritol, which are present in the cohesive non-free flowing sweetener composition in amounts of about 80% and about 20 %, respectively, by weight based on the total weight of the cohesive non-free flowing sweetener composition.

20. A method of making a cohesive non-free flowing sweetener composition comprising:

a) selecting a high intensity sweetener, a bulking agent, and a compound with a positive heat of solution so that the total heat of solution of the cohesive non-free flowing sweetener composition made therefrom is between about 5 kilocalories and about -20 kilocalories;

b) combining the components selected in step (a) to form a blend;

c) adding water to the blend;

d) forming the blend into a shape; and

e) drying the shape.

21. A method according to claim 20, wherein the high intensity sweetener is sucralose, which is present in the cohesive non-free flowing sweetener composition in an amount of about 0.4% by weight based on the total weight of the cohesive non-free flowing sweetener composition, the bulking agent is erythritol, which is present in the cohesive non-free flowing sweetener composition in an amount of about 60% by weight based on the total weight of the sweetener cube and the compound with a positive heat of solution comprises polydextrose and trehalose, which are present in the sweetener cube in amounts of about 10% and about 40%, respectively, by weight based on the total weight of the sweetener cube.

22. A sweetener cube made by the method of claim 18 or claim 20.