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(71) Applicant: **THE COCA-COLA COMPANY** [US/US]; One Coca-Cola Plaza, NW, Atlanta, GA 30313 (US).

(72) Inventors: **PRAKASH, Indra**; 9750 Talisman Drive, Alpharetta, GA 30022 (US). **HIGIRO, Juvenal**; 1008 Water Oak Trace, Acworth, GA 30102 (US).

(74) Agent: **SMYTHE, Nicole**; King & Spalding, 1180 Peachtree Street, Atlanta, GA 30309 (US).

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(54) Title: JUICE BEVERAGES WITH IMPROVED TASTE

(57) Abstract: Reduced calorie juice beverages are provided, the juice beverages comprising at least one juice, at least one high potency sweetener, and at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate.

JUICE BEVERAGES WITH IMPROVED TASTE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 63/338,234, filed May 4, 2022, which is incorporated herein in its entirety.

FIELD OF THE INVENTION

The present invention relates generally to reduced calorie juice beverages sweetened with certain high potency sweeteners and modified with certain organic salts of sodium and/or potassium.

BACKGROUND OF THE INVENTION

One hundred percent juices are often desirable to consumers looking to consume natural ingredients such as fruits. These types of juices may include fruit juices, concentrates, purees, nectars, and other ingredients obtained from fruits.

Not from concentrate, or NFC, juices tend to be popular with consumers for numerous reasons, such as their fresh taste and nutritional profile. These NFC juices must meet particular standards of identity criteria. Among these criteria are brix minimums and brix-to-acid ratio minimums. For example, the US Food and Drug Administration sets a standard for juices such as orange juice. In this regard 21 CFR Section 146.140 states that finished pasteurized orange juice is to contain not less than 10.5 percent by weight of orange juice soluble solids, exclusive of the solids of any added sweetening ingredients. This FDA regulation further states that the ratio of brix to grams of citric acid per 100 ml of juice is not less than a 10 to 1 ratio. The juice industry recognizes these criteria for pasteurized orange juice or single strength orange juice as applying to NFC orange juice. This same concept of standard of identity criteria applies as well to other pasteurized single strength juices.

Consumers increasingly prefer lower calorie versions of beverages generally, including juice beverages. Typically, juice beverages contain from 10 grams of sugar to 40 grams of sugar per 250 ml serving. Although sugar is not typically added to 100% juices, it is naturally present in fruits and vegetables.

Various approaches to reduced calorie juice beverages have been attempted.

The simplest approach is to dilute or water down the juice beverage, e.g., Trop50® (PepsiCo), a watered-down various of Tropicana orange juice said to have 50% less sugar and calories.

WO 2020/068581 describes reduced calorie juice beverages comprising a blend of juices, e.g., from 40 wt% to 85 wt% of a fruit juice base having 7.5 to 25 °Bx, a first liquid juice having a Brix from 2 to 7 °Bx, and a second liquid juice having a Brix from 1 to 6 °Bx. In particular, the reference describes juice blends containing orange juice, lettuce juice and coconut water, where the lettuce juice and coconut synergistically form a juice blend having a desirable organoleptic profile that eliminates or attenuates undesirable attributes of the one or more lower-calorie juices.

Stevia-based and monk fruit-based (*Luo Han Guo*) natural high potency sweeteners are popular choices for beverage formulations generally. However, these sweeteners are known to elicit off-tastes that are objectionable to consumers and taste different than sucrose, e.g., delayed sweetness onset, lingering sweet aftertaste, bitter taste, metallic taste, astringent taste, cooling taste, licorice-like taste, watery taste, and poor mouthfeel. With respect to juice beverages specifically that contain stevia sweeteners (e.g., rebaudioside A), principally orange juice, bitterness and mouthfeel are particularly problematic.

Reduced calorie orange juices comprising rebaudioside A are known (e.g., Simply® Light). US 20210329948 describes that rebaudioside A has a distinctive aftertaste as well as astringent and metallic “odd tastes.” US 20210329948 teaches using steviol glycosides other than rebaudioside A are preferable in reduced calorie juice beverages (e.g., rebaudioside M, rebaudioside D, rebaudioside N, rebaudioside O, and rebaudioside E) as well as (i) a natural sugars, (ii) less than 70 mg/100 mL of sodium and (iv) less than 70 mg/100 mL of potassium and/or less than 70 mg/100 mL of calcium.

U.S. Patent No. 10,874,121 describes “natural” reduced calorie juice beverages containing at least one fruit juice, water, rebaudioside A, and exogenously added homogenized pulp, where the exogenous homogenized pulp is said to enhance the mouthfeel of the beverage product by providing increased viscosity.

There remains a need for reduced calorie juice beverages that have improved taste and flavor profiles.

SUMMARY OF THE INVENTION

The present invention relates to reduced calorie juice beverages comprising certain high potency sweeteners and certain organic salts of potassium and/or sodium. The organic salts of potassium or sodium act to modulate the sensory profile of the reduced calorie juice beverage to provide improved sensory properties over comparable beverages in the absence of said organic salts.

In one aspect, the present invention provides a reduced calorie juice beverage comprising:

i. at least one juice;

ii. rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, rebaudioside B, monk fruit juice or concentrate, monk fruit extract, siamenoside I, mogroside V, thaumatin (and variants thereof), brazzein (and variants thereof), monellin (and variants thereof), sweet truffle protein (and variants thereof), sucralose, potassium acesulfame, aspartame, saccharin, cyclamate, and combinations thereof; and

iii. at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate.

Suitable juices include, but are not limited to, juices of citrus fruit (e.g., orange, grapefruit, lemon, lime, tangerine, tangelo), apricot, apple, kumquat, mango, pear, peach, pineapple, papaya, passion fruit, grape, strawberry, raspberry, cranberry, currant, bean, blueberry, blackberry, acai, lychee, kiwi, pomegranate, watermelon, rhubarb, aronia, tomato, celery, cucurbits, onion, watercress, cucumber, carrot, parsley, beet, asparagus, potato, turnip, rutabaga, and combinations thereof.

In certain embodiments, water is added to the juice beverage.

The high potency sweetener is present in a sweetening amount. In certain embodiments, the at least one high potency sweetener comprises rebaudioside A. In other embodiments, the at least one high potency sweetener comprises a steviol glycoside mixture comprising at least about 95% rebaudioside A by weight on a dry basis. In yet other embodiments, the at least one high potency sweetener comprises a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis. In still further other embodiments, the at least one high potency sweetener comprises a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis. In yet another embodiment, the at least one high potency sweetener comprises two steviol glycoside mixtures: a first steviol glycoside mixture comprising at least 95% rebaudioside A by weight on a dry basis and a second steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis.

In some embodiments, the juice beverages disclosed herein contain a single sodium salt selected from the group consisting of sodium gluconate, sodium citrate and sodium lactate. In other embodiments, the juice beverages disclosed herein contain a single potassium salt selected from the group consisting of potassium gluconate, potassium citrate, and potassium lactate.

The reduced calorie juice beverages can further comprise pulp, at least one natural flavor, and/or at least one organic acid.

The Brix of the reduced calorie beverages is from about 2 °Bx to about 7 °Bx.

DETAILED DESCRIPTION OF THE INVENTIO N

I. Definitions

"Juice", as used herein, refers to a beverage suitable for human consumption containing a liquid extracted from a fruit, vegetable, or plant. Examples of juices include, without limitation, fruit juice, vegetable juice, plant juice, plant water, and plant sap. Examples of juices also include juices that are reconstituted from-concentrate (FC) juices, not-from-concentrate (NFC) juices, purees, nectars or combinations thereof. Exemplary "juice beverages" include "fruit beverages," "fruit juices," "fruit mixed juices", "fruit grains-containing fruit juices", "fruit/vegetable mixed juices", and "fruit juice-containing beverages" defined in the "Ordinance for Enforcement of the Fair Competition Code for Labeling of Fruit Beverages and the like" enforced in 2016.

"Reduced calorie," as used herein, refers to a beverage comprising a mixture of caloric sweeteners (e.g., sucrose) and one or more non-sucrose sweeteners. Reduced-calorie beverages include mid-calorie beverages and low-calorie beverages.

"Mid-calorie beverage," as used herein, refers to a beverage that has from 41 to 60 calories per 8 oz. serving.

"Low-calorie beverage," as used herein, refers to a beverage that has from 6 to 40 calories per 8 oz. serving.

"Natural high potency sweetener" or "NHPS" as used herein, refers to any sweetener found naturally in nature and characteristically has a sweetness potency greater than sucrose, fructose, or glucose, yet has less calories. The natural high potency sweetener can be provided as a pure compound or, alternatively, as part of an extract.

"No salty taste", as used herein, refers to an inability to detect salty flavor in a beverage. Methods of determining whether a beverage tastes salty are known in the art, e.g., J. Giguère, et al., "Abstract 18991: Salt Taste Detection and Recognition Thresholds - Reliability of a Rapid Sensory Analysis Method", Circulation, November 25, 2014, Vol 130, Issue suppl 2. The temporal stability of a rapid sensory analysis based on the 3-alternative forced-choice (3-AFC) method (ASTM E679) was tested with 30 adult volunteers. Detection Threshold (DT) and Recognition Threshold (RT) for salt were determined using a series of ascending concentrations.

"Citrus pulp" refers to the insoluble material found in the edible section of a citrus fruit. It includes juice sacs (whole and ruptured) and segment walls.

"Synthetic high potency sweetener," as used herein, refers to any composition which is not found naturally in nature and characteristically has a sweetness potency greater than sucrose, fructose, or glucose, yet has less calories.

II. Juice Beverages

The present disclosure relates to juice beverages having reduced calorie content. The juice beverages comprise at least one juice, at least one high potency sweetener, and at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate.

It has been found that the described sodium or potassium salts can be used to effectively improve the taste attributes of the at least one high potency sweetener and provide juice beverages with improved sensory properties compared to a corresponding juice beverage in the absence of the sodium or potassium salt. Exemplary taste attribute modulations include decreasing or eliminating bitterness, decreasing or eliminating bitter linger, decreasing or eliminating sourness, decreasing or eliminating astringency, decreasing or eliminating saltiness, decreasing or eliminating metallic notes, improving mouthfeel, decreasing or eliminating sweetness linger, increasing sweetness onset and increasing sweetness intensity. Multiple taste attributes can be modulated simultaneously, such that the salt-containing juice beverage, overall, has more sucrose-sweetened characteristics compared to a corresponding juice beverage without the salt(s). Methods of quantifying improvement in sucrose-sweetened characteristics are known in the art and include taste testing and histogram mapping with isosweet sucrose-sweetened beverage controls.

The reduced calorie juice beverages of the present invention preferably contain from about 40 to about 80, from about 40 to about 60, or about 50 calories per 8 US fluid ounce (240 mL) serving.

In one embodiment, the juice beverage comprises not-from-concentrate (NFC) or from-concentrate (FC) juices. In certain exemplary embodiments, the juice beverage comprises citrus juice. In certain exemplary embodiments, the juice beverage comprises a not-from-concentrate (NFC) orange juice. Other types of fruit or vegetable juices include, but are not limited to, juices of citrus fruit (e.g., orange, grapefruit, lemon, lime, tangerine, tangelo), apricot, apple, kumquat, mango, pear, peach, pineapple, papaya, passion fruit, grape, strawberry, raspberry, cranberry, currant, bean, blueberry, blackberry, acai, lychee, kiwi, pomegranate, watermelon, rhubarb, aronia, tomato, celery, cucurbits, onion, watercress, cucumber, carrot, parsley, beet, asparagus, potato, turnip, rutabaga, and combinations thereof.

In certain exemplary embodiments, the juice beverage comprises juice (e.g., citrus juice, orange juice) in an amount from about 10% to about 90% by weight of the beverage, e.g., from about 10% to about 80%, from about 10% to about 70%, from about 10% to about 60%, from about 10% to about 50%, from about 10% to about 40%, from about 10% to about 30%, from about 10% to about 20%, from about 20% to about 90%, from about 20% to about 80%, from about 20% to about 70%, from about 20% to about 60%, from about 20% to about 50%, from about 20% to about 40%, from about 20% to about 30%, from about 30% to about 90%, from about 30% to about 80%, from about 30% to about 70%, from about 30% to about 60%, from about 30% to about 50%, from about 30% to about 40%, from about 40% to about 90%, from about 40% to about 80%, from about 40% to about 70%, from about 40% to about 60%, from about 40% to about 50%, from about 50% to about 90%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 90%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 90%, from about 70% to about 80% or from about 80% to about 90%. In particular embodiments, the beverage comprises from about 40 wt% to about 60 wt% juice.

Full strength juice beverages can be formed from a beverage concentrate by adding further volumes of water to the concentrate. In other embodiments, a full-strength beverage is directly prepared without the formation of a concentrate and subsequent dilution.

In embodiments for which the juice beverage is not 100% juice or is from concentrate, water can be added. Purified or filtered water can be used to prepare the beverages disclosed here, and water of a standard beverage quality can be employed in order not to adversely

affect beverage taste, odor, or appearance. In certain embodiments, the water is "treated water," which refers to water that has been treated to reduce the total dissolved solids of the water prior to optional supplementation. Methods of producing treated water are known to those of ordinary skill in the art and include deionization, distillation, filtration and reverse osmosis ("r-o"), among others. The terms "treated water," "purified water,", "demineralized water," "distilled water," and "r-o water" are generally synonymous, referring to water from which substantially all mineral content has been removed, typically containing no more than about 500 ppm total dissolved solids, e.g. 250 ppm total dissolved solids.

In certain exemplary embodiments, water is added at a level of from about 0% to about 90% by weight of the juice beverage, e.g., 10% to about 90% by weight of the beverage, e.g., from about 10% to about 80%, from about 10% to about 70%, from about 10% to about 60%, from about 10% to about 50%, from about 10% to about 40%, from about 10% to about 30%, from about 10% to about 20%, from about 20% to about 90%, from about 20% to about 80%, from about 20% to about 70%, from about 20% to about 60%, from about 20% to about 50%, from about 20% to about 40%, from about 20% to about 30%, from about 30% to about 90%, from about 30% to about 80%, from about 30% to about 70%, from about 30% to about 60%, from about 30% to about 50%, from about 30% to about 40%, from about 40% to about 90%, from about 40% to about 80%, from about 40% to about 70%, from about 40% to about 60%, from about 40% to about 50%, from about 50% to about 90%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 90%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 90%, from about 70% to about 80% or from about 80% to about 90%. In particular embodiments, the juice beverage comprises from about 40 wt% to about 60 wt% water.

The high potency sweetener is present in a sweetening amount, i.e., in an amount above its sweetness recognition threshold such that it is perceptibly sweet. The high potency sweetener can be any known high potency sweetener, including natural and synthetic high potency sweeteners.

Non-limiting examples of natural high potency sweeteners include stevia sweeteners and steviol glycoside sweeteners, such as rebaudioside M, rebaudioside D, rebaudioside A, rebaudioside AM, rebaudioside N, rebaudioside O, rebaudioside E, steviolmonoside, steviolbioside, rubusoside, dulcoside B, dulcoside A, rebaudioside B, rebaudioside G, stevioside, rebaudioside C, rebaudioside F, rebaudioside I, rebaudioside H, rebaudioside L, rebaudioside K, rebaudioside J, rebaudioside M2, rebaudioside D2, rebaudioside S, rebaudioside T, rebaudioside U, rebaudioside V, rebaudioside W, rebaudioside Z1,

rebaudioside Z2, rebaudioside IX, enzymatically glucosylated steviol glycosides, and combinations thereof.

In a particular embodiment, the high potency sweetener is a steviol glycoside sweetener selected from the group consisting of rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, and rebaudioside B.

Steviol glycoside sweeteners can be provided in pure form or as part of a mixture. The steviol glycoside mixture sweetener typically has a total steviol glycoside content of about 95% by weight or greater on a dry basis. The remaining 5% comprises other non-steviol glycoside compounds, e.g. by-products from extraction or purification processes. In some embodiments, the steviol glycoside blend sweetener has a total steviol glycoside content of about 96% or greater, about 97% or greater, about 98% or greater or about 99% or greater.

In certain embodiments, a steviol glycoside mixture comprises at least about 5% of a particular steviol glycoside by weight on a dry basis, such as, for example, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 95% or at least about 97%.

The steviol glycoside mixture may comprise at least about 50% rebaudioside A by weight on a dry basis, such as, for example, from about 50% to about 99%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80%, from about 80% to about 99%, or from about 90% to about 99%.

The steviol glycoside mixture may comprise at least about 95% rebaudioside A by weight on a dry basis, such as, for example, from about 95% to about 99%, from about 96% to about 99%, from about 97% to about 99%, or from about 98% to about 99%.

The steviol glycoside mixture may comprise at least about 50% rebaudioside M by weight on a dry basis, such as, for example, from about 50% to about 99%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80%, from about 80% to about 99%, or from about 90% to about 99%.

The steviol glycoside mixture may comprise at least about 95% rebaudioside M by weight on a dry basis, such as, for example, from about 95% to about 99%, from about 96% to about 99%, from about 97% to about 99%, or from about 98% to about 99%.

The steviol glycoside mixture may comprise at least about 50% rebaudioside AM by weight on a dry basis, such as, for example, from about 50% to about 99%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80%, from about 80% to about 99%, or from about 90% to about 99%.

The steviol glycoside mixture may comprise at least about 95% rebaudioside AM by weight on a dry basis, such as, for example, from about 95% to about 99%, from about 96% to about 99%, from about 97% to about 99%, or from about 98% to about 99%.

The steviol glycoside mixture may comprise at least about 50% rebaudioside E by weight on a dry basis, such as, for example, from about 50% to about 99%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80%, from about 80% to about 99%, or from about 90% to about 99%.

The steviol glycoside mixture may comprise at least about 95% rebaudioside E by weight on a dry basis, such as, for example, from about 95% to about 99%, from about 96% to about 99%, from about 97% to about 99%, or from about 98% to about 99%.

The steviol glycoside mixture may comprise at least about 50% rebaudioside D by weight on a dry basis, such as, for example, from about 50% to about 99%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80%, from about 80% to about 99%, or from about 90% to about 99%.

The steviol glycoside mixture may comprise at least about 95% rebaudioside D by weight on a dry basis, such as, for example, from about 95% to about 99%, from about 96% to about 99%, from about 97% to about 99%, or from about 98% to about 99%.

The steviol glycoside mixture may comprise at least about 50% rebaudioside E by weight on a dry basis, such as, for example, from about 50% to about 99%, from about 50%

to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80%, from about 80% to about 99%, or from about 90% to about 99%.

The steviol glycoside mixture may comprise at least about 95% rebaudioside E by weight on a dry basis, such as, for example, from about 95% to about 99%, from about 96% to about 99%, from about 97% to about 99%, or from about 98% to about 99%.

The steviol glycoside mixture may comprise at least about 50% rebaudioside N by weight on a dry basis, such as, for example, from about 50% to about 99%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80%, from about 80% to about 99%, or from about 90% to about 99%.

The steviol glycoside mixture may comprise at least about 95% rebaudioside N by weight on a dry basis, such as, for example, from about 95% to about 99%, from about 96% to about 99%, from about 97% to about 99%, or from about 98% to about 99%.

The steviol glycoside mixture may comprise at least about 50% rebaudioside B by weight on a dry bsis, such as, for example, from about 50% to about 99%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80%, from about 80% to about 99%, or from about 90% to about 99%.

The steviol glycoside mixture may comprise at least about 95% rebaudioside B by weight on a dry basis, such as, for example, from about 95% to about 99%, from about 96% to about 99%, from about 97% to about 99%, or from about 98% to about 99%.

The concentration of the steviol glycoside sweetener in the juice beverage can vary from about 25 ppm to about 600 ppm, such as, for example, from about 25 ppm to about 500 ppm, from about 25 ppm to about 400 ppm, from about 25 ppm to about 300 ppm, from about 25 ppm to about 200 ppm, from about 25 ppm to about 100 ppm, from about 100 ppm to about 600 ppm, from about 100 ppm to about 500 ppm, from about 100 ppm to about 400 ppm, from about 100 ppm to about 300 ppm, from about 100 ppm to about 200 ppm, from about 200 ppm to about 600 ppm, from about 200 ppm to about 500 ppm, from about 200 ppm to about 400 ppm, from about 200 ppm to about 300 ppm, from about 300 ppm to about 600 ppm, from

about 300 ppm to about 500 ppm, from about 300 ppm to about 400 ppm, from about 400 ppm to about 600 ppm, from about 400 ppm to about 500 ppm or from about 500 ppm to about 600 ppm. In a particular embodiment, the steviol glycoside sweetener is present in a concentration from about 100 ppm to about 300 ppm.

Exemplary natural high potency sweeteners also includes Luo Han Guo and the related mogroside compounds, such as monk fruit juice or concentrate, monk fruit extract, mogroside V, grosmogroside I, mogroside IA, mogroside IE, 11-oxomogroside IA, mogroside II, mogroside II A, mogroside II B, mogroside II E, 7-oxomogroside II E, mogroside III, Mogroside IIIe, 11-oxomogroside IIIE, 11- deoxymogroside III, mogroside IV, Mogroside IVA, 11-oxomogroside IV, 11-oxomogroside IVA, mogroside V, isomogroside V, 11-deoxymogroside V, 7-oxomogroside V, 11-oxomogroside V, isomogroside V, mogroside VI, mogrol, 11-oxomogrol, siamenoside I, isomers of siamenoside I (e.g. those disclosed in 20170119032; incorporated by reference in its entirety), 11-oxo-siamenoside I, 11-oxo-isomers of siamenoside I, (3β,9β,10α,11α,24R)-3-[(4-O-β-D-glucospyranosyl-6-O-β-D-glucopyranosyl]-25-hydroxyl-9-methyl-19-norlanost-5-en-24-yl-[2-O-β-D-glucopyranosyl-6-O-β-D-glucopyranosyl]- β-D-glucopyranoside); (3β, 9β, 10α, 11α, 24R)-[(2-O- β-D-glucopyranosyl-6-O- β-D-glucopyranosyl- β-D- glucopyranosyl)oxy]-25-hydroxy-9-methyl-19-norlanost-5-en-24-yl-[2-O- β-D-glucopyranosyl-6-O-β-D-glucopyranosyl]-β-D-glucopyranoside); and (3β, 9β, 10α, 11α, 24R)-[(2-O-β-D-glucopyranosyl-6-O-β-D-glucopyranosyl- β-D-glucopyranosyl)oxy]-25-hydroxy-9-methyl-19-norlanost-5-en-24-yl-[2-O-β-D-glucopyranosyl-6-O-β-D-glucopyranosyl]-β-D-glucopyranoside).

In particular embodiments, the mogroside sweetener is siamenoside I or mogroside V.

Mogroside sweeteners can be provided in pure form or as part of a mixture. In certain embodiments, a mogroside mixture comprises at least about 5% of a particular mogroside by weight on a dry basis, such as, for example, at least about 10%, at least about 20%, at least about 30%, at least about 40%, at least about 50%, at least about 60%, at least about 70%, at least about 80%, at least about 90%, at least about 95% or at least about 97%.

The mogroside mixture may comprise at least about 50% siamenoside I by weight on a dry basis, such as, for example, from about 50% to about 99%, from about 50% to about 80%, from about 50% to about 70%, from about 50% to about 60%, from about 60% to about 99%, from about 60% to about 80%, from about 60% to about 70%, from about 70% to about 99%, from about 70% to about 80% and from about 80% to about 99%.

The mogroside mixture may comprise at least about 25% mogroside V by weight on a dry basis, such as, for example, from about 25% to about 99%, from about 25% to about 80%, from about 25% to about 70%, from about 25% to about 60%, from about 25% to about 50%, from about 25% to about 40%, or from about 25% to about 30%.

In one embodiment, the mogroside sweetener is monk fruit extract. In certain embodiments, the monk fruit extract comprises about 45% or greater mogroside V by weight on a dry basis, such as, for example, about 50% or greater mogroside V, about 55% or greater mogroside V, about 60% or greater mogroside V, about 65% or greater mogroside V, about 70% or greater mogroside V, about 75% or greater mogroside V, about 80% or greater mogroside V, about 85% or greater mogroside V, about 90% or greater mogroside V or about 95% or greater mogroside V.

In another embodiment, the mogroside sweetener is monk fruit juice or monk fruit juice concentrate. The concentrate typically comprises at least 3.5 wt% mogroside V.

The concentration of the mogroside sweetener or mogroside mixture sweetener in the juice beverage can vary from about 25 ppm to about 600 ppm, such as, for example, from about 25 ppm to about 500 ppm, from about 25 ppm to about 400 ppm, from about 25 ppm to about 300 ppm, from about 25 ppm to about 200 ppm, from about 25 ppm to about 100 ppm, from about 100 ppm to about 600 ppm, from about 100 ppm to about 500 ppm, from about 100 ppm to about 400 ppm, from about 100 ppm to about 300 ppm, from about 100 ppm to about 200 ppm, from about 200 ppm to about 600 ppm, from about 200 ppm to about 500 ppm, from about 200 ppm to about 400 ppm, from about 200 ppm to about 300 ppm, from about 300 ppm to about 600 ppm, from about 300 ppm to about 500 ppm, from about 300 ppm to about 400 ppm, from about 400 ppm to about 600 ppm, from about 400 ppm to about 500 ppm or from about 500 ppm to about 600 ppm.

Other exemplary natural high potency sweeteners include Amai proteins, monatin and its salts (monatin SS, RR, RS, SR), curculin, glycyrrhizic acid and its salts, thaumatin (and variants thereof, e.g., thaumatin I, thaumatin II) monellin (and variants thereof), miraculin, mabinlin, brazzein (and variants thereof), sweet truffle protein (and variants thereof), hernandulcin, phyllodulcin, glycyphyllin, phloridzin, trilobatin, baiyunoside, osladin, polypodoside A, pterocaryoside A, pterocaryoside B, mukurozioside, phlomisoside I, periandrin I, abrusoside A, and cyclocarioside I.

Sweet truffle protein refers to the sweet proteins recently identified from fungal proteins, e.g., *M. terfezoides* gleba, also called "Myd polypeptides" according to US Patent Application No. 2021/0401013, incorporated herein by reference.

Non-limiting examples of synthetic high potency sweeteners include sucralose, potassium acesulfame, aspartame, alitame, saccharin, neohesperidin dihydrochalcone synthetic derivatives, cyclamate, neotame, dulcin, suosan, cyclamate, saccharin, advantame, and salts thereof.

In exemplary embodiments, the high potency sweetener is selected from the group consisting of rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, rebaudioside B, monk fruit juice or concentrate, monk fruit extract, siamenoside I, mogroside V, thaumatin (and variants thereof), brazzein (and variants thereof), monellin (and variants thereof), sweet truffle protein (and variants thereof), sucralose, potassium acesulfame, aspartame, saccharin, cyclamate, and combinations thereof.

In certain embodiments, the at least one high potency sweetener comprises rebaudioside A. In other embodiments, the at least one high potency sweetener comprises a steviol glycoside mixture comprising at least about 95% rebaudioside A by weight on a dry basis. In yet other embodiments, the at least one high potency sweetener comprises a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis. In still further other embodiments, the at least one high potency sweetener comprises a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis. In yet another embodiment, the at least one high potency sweetener comprises two steviol glycoside mixtures: the first steviol glycoside mixture comprising at least 95% rebaudioside A by weight on a dry basis and the second steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis.

In certain embodiments, the juice beverage does not contain rebaudioside M or rebaudioside D. In certain other embodiments, the juice beverage does not contain rebaudioside M or rebaudioside D in an amount greater than about 1% by weight, greater than about 5% by weight, greater than about 10% by weight, or greater than about 20% by weight. In still other embodiments, the juice beverage does not contain a steviol glycoside mixture containing rebaudioside M or rebaudioside D. In yet other embodiments, the juice beverage does not contain a steviol glycoside mixture containing rebaudioside M or rebaudioside D in an amount greater than about 1% by weight on a dry basis, greater than about 5% by weight on a dry basis, or greater than about 10% by weight on a dry basis.

The high potency sweetener is present in a sweetening amount, i.e., in an amount above the sweetness recognition threshold such that it is perceptibly sweet. The concentration of the high potency sweetener can vary from about 1 ppm to about 600 ppm, from about 1 ppm to about 500 ppm, from about 1 ppm to about 400 ppm, about 1 ppm to about 300 ppm, from about 1 ppm to about 200 ppm, from about 1 ppm to about 100 ppm, from about 1 ppm to about 50 ppm, from about 1 ppm to about 25 ppm, from about 1 ppm to about 15 ppm or about 1 ppm to about 10 ppm.

The sweetness of the juice beverages herein is provided by (a) the natural carbohydrates present in the juice (e.g., sucrose, glucose and fructose) and (b) the at least one high potency sweetener. Therefore, in some embodiments, the juice beverages of the present invention do not contain added caloric sweeteners, e.g., sucrose or glucose.

The juice beverages of the present invention comprise at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverages of the present invention comprise at least one salt selected from sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. In certain embodiments, the at least one salt is a sodium salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, and combinations thereof. In other certain embodiments, the at least one salt is a potassium salt selected from the group consisting of potassium gluconate, potassium citrate, potassium lactate, and combinations thereof. It has been found that, in some instances, salts containing the same cation (here, sodium or potassium) provide superior taste attribute modulation than mixtures of sodium and potassium-containing salts.

The concentration of the at least one salt in the juice beverage can be from about 250 ppm to about 500 ppm, such as, for example, from about 250 ppm to about 400 ppm, from about 250 ppm to about 300 ppm, from about 300 ppm to about 500 ppm, from about 300 ppm to about 400 ppm, or from about 400 ppm to about 500 ppm. It has been found that such concentrations of the at least one salt provide superior results compared to both lower and higher concentrations. For example, concentrations of 750-1,000 ppm provide undesirable flavor changes.

It has been found that, in some instances, the described potassium and sodium salts provide superior taste attribute modulation compared to magnesium or calcium salts. Therefore, in some embodiments, the juice beverages disclosed herein do not contain

magnesium or calcium salts. In other embodiments, the juice beverages disclosed herein do not contain magnesium or calcium salts of gluconate, citrate, or lactate.

It has also been found that, in some instances, a single sodium or potassium salt contemplated here, e.g., potassium gluconate or sodium gluconate, provides superior taste attribute modulation to mixtures of sodium-containing salts or potassium-containing salts. Therefore, in some embodiments, the juice beverages disclosed herein contain a single sodium salt selected from the group consisting of sodium gluconate, sodium citrate, and sodium lactate. In other embodiments, the juice beverages disclosed herein contain a single potassium salt selected from the group consisting of potassium gluconate, potassium citrate, and potassium lactate.

In certain embodiments, the juice beverages do not contain potassium, sodium, calcium or magnesium salts of inorganic ions, e.g., chloride, fluoride, phosphate, monohydrogen phosphate, dihydrogen phosphate, sulfate, bisulfate, nitrate, carbonate, or bicarbonate.

The juice beverages can also contain pulp, typically comprising particles of the soft, fleshy part of the fruit or vegetable, which has been removed from the fruit or vegetable along with the juice during extraction. For instance, citrus pulp may include fruit vesicles that contain juice, or fragments of fruit vesicles or membranes. The citrus pulp may be produced from any citrus fruit. Non-limiting examples include orange, lime, lemon, grapefruit, tangerine, citrange, tangelo, pomelo, mandarin, citron, and kumquat pulp, and combinations thereof. Suitable forms of citrus pulp include aseptic pulp, frozen pulp, washed pulp, dried pulp, and homogenized pulp. Aseptic pulp may be prepared by passing a juice stream through primary finishers. The back-pressure settings on the pulp finishers will generally be quite low so that the pulp obtained still has high juice content. The resulting aseptic pulp is roughly 50% juice and 50% pulp solids and is pasteurized before packaging. Washed pulp is generally produced in the same manner as aseptic pulp. The pulp typically undergoes additional finishing steps after pasteurization to remove additional juice and liquid, after which the pulp is packaged and frozen. Typically, in a 3- or 4-stage countercurrent finishing train, about 60% of the total “solids from pulp” are removed as soluble orange solids, the remaining 40% comprising true “pulp solids (insolubles). Homogenization of juice pulp will decrease the size of the pulp particles such that they are sufficiently small to provide a homogeneous mouthfeel and very slowly settle out of suspension. For example, the suspended pulp typically settles to the bottom of the beverage within about 24-32 hours

In certain embodiments, the juice beverages disclosed herein do not contain homogenized juice pulp.

The juice beverages of the present invention can also contain at least one natural flavor, e.g., fruit or herb flavors. The flavor can be provided in any suitable form.

Exemplary fruit flavors include, but are not limited to, açai, apple, apricot, avocado, banana, blackberry, black currant, blueberry, breadfruit, cantaloupe, carambola, cherimoya, cherry, clementine, coconut, cranberry, custard-apple, date, dragonfruit, durian, elderberry, feijoa, fig, gooseberry, grapefruit, grape, guava, honeydew melon, jackfruit, java-plum, jujube fruit, kiwifruit, kumquat, lemon, lime, longan, loquat, lychee, mandarin, mango, mangosteen, mulberry, nectarine, orange, papaya, passion fruit, peach, pear, persimmon, pitaya (dragonfruit), pineapple, pitanga, plantain, plum, pomegranate, prickly pear, prune, pummelo, quince, raspberry, rhubarb, rose-apple, sapodilla, sapote, soursop, strawberry, sugar-apple, tamarine, tangerine, watermelon, and combinations thereof.

Exemplary herb flavors include, but are not limited to chamomile, peppermint, hibiscus, lavender, marigold, chrysanthemum, ginger, turmeric, and combinations thereof.

In a particular embodiment, the juice beverage, e.g., orange juice, contains orange flavor.

The juice beverages can also contain at least one organic acid, which serves one or more additional functions, including, for example, lending tartness to the taste of the beverage, enhancing palatability, increasing thirst quenching effect, and acting as a mild preservative. Exemplary organic acids include citric acid, malic acid, ascorbic acid, tartaric acid, lactic acid, adipic acid, fumaric acid, gluconic acid, succinic acid, and maleic acid. The particular acid or acids chosen and the amount used will depend, in part, on the other ingredients, the desired shelf life, as well as effects on the beverage pH, titratable acidity, and taste. The juice beverage contains at least one organic acid in an amount from about 0.1% to about 1.0% by weight, e.g., about 0.2% to about 0.7% by weight, or about 0.3% to about 0.6% by weight. In a particular embodiment, the juice beverage contains citric acid in an amount from about 0.1% to about 1.0% by weight.

A non-limiting example of the pH range of the juice beverage may be from about 2 about 7, such as, for example, from about 3 to about 5. In a particular embodiment, the pH of an orange juice is about 3 to about 4.5.

The amount of sucrose in a reference solution may be described in degrees Brix (°Bx). One degree Brix is 1 gram of sucrose in 100 grams of solution and represents the strength of the solution as percentage by weight (% w/w) (strictly speaking, by mass). The juice beverages of the present invention are from about 2 °Bx to about 7 °Bx, such as, for example, from about 4 °Bx to about 6 °Bx, or about 5 °Bx to about 6 °Bx.

A. Formulations

A reduced calorie juice beverage of the present invention comprises (i) at least one juice; (ii) at least one high potency sweetener; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate.

In one embodiment, a reduced calorie juice beverage comprises (i) at least one juice selected from the group consisting of juices of citrus fruit (e.g., orange, grapefruit, lemon, lime, tangerine, tangelo), apricot, apple, kumquat, mango, pear, peach, pineapple, papaya, passion fruit, grape, strawberry, raspberry, cranberry, currant, bean, blueberry, blackberry, acai, lychee, kiwi, pomegranate, watermelon, rhubarb, aronia, tomato, celery, cucurbits, onion, watercress, cucumber, carrot, parsley, beet, asparagus, potato, turnip, rutabaga, and combinations thereof; (ii) at least one high potency sweetener; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage can comprise juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above.

In a more particular embodiment, a reduced calorie juice beverage comprises (i) at least one juice selected from the group consisting of juices of citrus fruit (e.g., orange, grapefruit, lemon, lime, tangerine, tangelo), apricot, apple, kumquat, mango, pear, peach, pineapple, papaya, passion fruit, grape, strawberry, raspberry, cranberry, currant, bean, blueberry, blackberry, acai, lychee, kiwi, pomegranate, watermelon, rhubarb, aronia, tomato, celery, cucurbits, onion, watercress, cucumber, carrot, parsley, beet, asparagus, potato, turnip, rutabaga, and combinations thereof; (ii) at least one high potency sweetener selected from the group consisting of rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, rebaudioside B, monk fruit juice or concentrate, monk fruit extract, siamenoside I, mogroside V, thaumatin (and variants thereof), brazzein (and variants thereof), monellin (and variants thereof), sweet truffle protein (and variants thereof), sucralose, potassium acesulfame, aspartame, saccharin, cyclamate, and combinations thereof; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice

beverage comprises juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises the at least one high potency sweetener in an amount from about 1 ppm to about 600 ppm, as discussed above. The juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above.

In a particular embodiment, a reduced calorie orange juice beverage comprises (i) orange juice; (ii) at least one high potency sweetener selected from the group consisting of rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, rebaudioside B, monk fruit juice or concentrate, monk fruit extract, siamenoside I, mogroside V, thaumatin (and variants thereof), brazzein (and variants thereof), monellin (and variants thereof), sweet truffle protein (and variants thereof), sucralose, potassium acesulfame, aspartame, saccharin, cyclamate, and combinations thereof; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises the at least one high potency sweetener in an amount from about 1 ppm to about 600 ppm, as discussed above. The juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above.

In a more particular embodiment, a reduced calorie orange juice beverage comprises (i) orange juice; (ii) at least one high potency sweetener comprising rebaudioside A; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises rebaudioside A in an amount from about 25 to about 600 ppm, or about 100 ppm to about 300 ppm, as discussed above. The juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above.

In another more particular embodiment, a reduced calorie orange juice beverage comprises (i) orange juice; (ii) at least one high potency sweetener comprising a steviol glycoside mixture comprising at least about 95% rebaudioside A by weight on a dry basis; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises

the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or about 100 ppm to about 300 ppm as discussed above. The juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above.

Alternatively, a reduced calorie orange juice beverage comprises (i) orange juice; (ii) at least one high potency sweetener comprising a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or about 100 ppm to about 300 ppm, as discussed above. The juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above.

In another embodiment, a reduced calorie orange juice beverage comprises (i) orange juice; (ii) at least one high potency sweetener comprising a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or about 100 ppm to about 300 ppm, as discussed above. The juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above.

In still another embodiment, a reduced calorie orange juice beverage comprises (i) orange juice; (ii) at least one high potency sweetener comprising two steviol glycoside mixtures: the first steviol glycoside mixture containing at least about 95% rebaudioside A by weight on a dry basis and the second steviol glycoside mixture containing at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600

ppm, or about 100 ppm to about 300 ppm as discussed above. The juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above.

In a more particular embodiment, a reduced calorie orange juice beverage comprises (i) orange juice; (ii) at least one high potency sweetener comprising two steviol glycoside mixtures: the first steviol glycoside mixture containing at least about 95% rebaudioside A by weight on a dry basis and the second steviol glycoside mixture containing at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis; and (iii) a salt selected from sodium gluconate or a potassium gluconate. The juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or about 100 ppm to about 300 ppm, as discussed above. The juice beverage comprises the salt in an amount from about 250 ppm to about 500 ppm, more preferably from about 400 ppm to about 500 ppm, as discussed above.

B. Functional Ingredients

The juice beverages described herein optionally include at least one functional ingredient described herein below.

Exemplary functional ingredients include, but are not limited to, saponins, antioxidants, dietary fiber sources, fatty acids, vitamins, glucosamine, minerals, preservatives, hydration agents, probiotics, prebiotics, weight management agents, osteoporosis management agents, phytoestrogens, long chain primary aliphatic saturated alcohols, phytosterols and combinations thereof.

In certain embodiments, the functional ingredient is at least one saponin. As used herein, the at least one saponin may comprise a single saponin or a plurality of saponins as a functional ingredient for the composition provided herein. Saponins are glycosidic natural plant products comprising an aglycone ring structure and one or more sugar moieties. Non-limiting examples of specific saponins for use in particular embodiments of the invention include group A acetyl saponin, group B acetyl saponin, and group E acetyl saponin. Several common sources of saponins include soybeans, which have approximately 5% saponin content by dry weight, soapwort plants (*Saponaria*), the root of which was used historically as soap, as well as alfalfa, aloe, asparagus, grapes, chickpeas, yucca, and various other beans and weeds. Saponins may be obtained from these sources by using extraction techniques well known to those of ordinary skill in the art. A description of conventional extraction techniques can be found in U.S. Pat. Appl. No. 2005/0123662.

In certain embodiments, the functional ingredient is at least one antioxidant. As used herein, “antioxidant” refers to any substance which inhibits, suppresses, or reduces oxidative damage to cells and biomolecules.

Examples of suitable antioxidants for embodiments of this invention include, but are not limited to, vitamins, vitamin cofactors, minerals, hormones, carotenoids, carotenoid terpenoids, non-carotenoid terpenoids, flavonoids, flavonoid polyphenolics (e.g., bioflavonoids), flavonols, flavones, phenols, polyphenols, esters of phenols, esters of polyphenols, nonflavonoid phenolics, isothiocyanates, and combinations thereof. In some embodiments, the antioxidant is vitamin A, vitamin C, vitamin E, ubiquinone, mineral selenium, manganese, melatonin, α-carotene, β-carotene, lycopene, lutein, zeanthin, crypoxanthin, reservatol, eugenol, quercetin, catechin, gossypol, hesperetin, curcumin, ferulic acid, thymol, hydroxytyrosol, tumeric, thyme, olive oil, lipoic acid, glutathinone, gutamine, oxalic acid, tocopherol-derived compounds, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), ethylenediaminetetraacetic acid (EDTA), tert-butylhydroquinone, acetic acid, pectin, tocotrienol, tocopherol, coenzyme Q10, zeaxanthin, astaxanthin, canthaxantin, saponins, limonoids, kaempfedrol, myricetin, isorhamnetin, proanthocyanidins, quercetin, rutin, luteolin, apigenin, tangeritin, hesperetin, naringenin, erodictyol, flavan-3-ols (e.g., anthocyanidins), gallocatechins, epicatechin and its gallate forms, epigallocatechin and its gallate forms (ECGC) theaflavin and its gallate forms, thearubigins, isoflavone, phytoestrogens, genistein, daidzein, glycitein, anythocyanins, cyaniding, delphinidin, malvidin, pelargonidin, peonidin, petunidin, ellagic acid, gallic acid, salicylic acid, rosmarinic acid, cinnamic acid and its derivatives (e.g., ferulic acid), chlorogenic acid, chicoric acid, gallotannins, ellagitannins, anthoxanthins, betacyanins and other plant pigments, silymarin, citric acid, lignan, antinutrients, bilirubin, uric acid, R-α-lipoic acid, N-acetylcysteine, emblicanin, apple extract, apple skin extract (applephenon), rooibos extract red, rooibos extract, green, hawthorn berry extract, red raspberry extract, green coffee antioxidant (GCA), aronia extract 20%, grape seed extract (VinOseed), cocoa extract, hops extract, mangosteen extract, mangosteen hull extract, cranberry extract, pomegranate extract, pomegranate hull extract, pomegranate seed extract, hawthorn berry extract, pomella pomegranate extract, cinnamon bark extract, grape skin extract, bilberry extract, pine bark extract, pycnogenol, elderberry extract, mulberry root extract, wolfberry (gogi) extract, blackberry extract, blueberry extract, blueberry leaf extract, raspberry extract, turmeric extract, citrus bioflavonoids, black currant, ginger, acai powder, green coffee bean extract, green tea extract, and phytic acid, or combinations thereof. In alternate embodiments, the antioxidant is a synthetic antioxidant such as butylated hydroxytolune or butylated hydroxyanisole, for example. Other sources of suitable antioxidants for embodiments of this invention include, but are not limited to, fruits, vegetables,

tea, cocoa, chocolate, spices, herbs, rice, organ meats from livestock, yeast, whole grains, or cereal grains.

Particular antioxidants belong to the class of phytonutrients called polyphenols (also known as “polyphenolics”), which are a group of chemical substances found in plants, characterized by the presence of more than one phenol group per molecule. Suitable polyphenols for embodiments of this invention include catechins, proanthocyanidins, procyanidins, anthocyanins, quercerin, rutin, reservatrol, isoflavones, curcumin, punicalagin, ellagitannin, hesperidin, naringin, citrus flavonoids, chlorogenic acid, other similar materials, and combinations thereof.

In one embodiment, the antioxidant is a catechin such as, for example, epigallocatechin gallate (EGCG). In another embodiment, the antioxidant is chosen from proanthocyanidins, procyanidins or combinations thereof. In particular embodiments, the antioxidant is an anthocyanin. In still other embodiments, the antioxidant is chosen from quercetin, rutin or combinations thereof. In one embodiment, the antioxidant is reservatrol. In another embodiment, the antioxidant is an isoflavone. In still another embodiment, the antioxidant is curcumin. In a yet further embodiment, the antioxidant is chosen from punicalagin, ellagitannin or combinations thereof. In a still further embodiment, the antioxidant is chlorogenic acid.

In certain embodiments, the functional ingredient is at least one dietary fiber. Numerous polymeric carbohydrates having significantly different structures in both composition and linkages fall within the definition of dietary fiber. Such compounds are well known to those skilled in the art, non-limiting examples of which include non-starch polysaccharides, lignin, cellulose, methylcellulose, the hemicelluloses, β-glucans, pectins, gums, mucilage, waxes, inulins, oligosaccharides, fructooligosaccharides, cyclodextrins, chitins, and combinations thereof. Although dietary fiber generally is derived from plant sources, indigestible animal products such as chitins are also classified as dietary fiber. Chitin is a polysaccharide composed of units of acetylglucosamine joined by β(1-4) linkages, similar to the linkages of cellulose.

In certain embodiments, the functional ingredient is at least one fatty acid. As used herein, “fatty acid” refers to any straight chain monocarboxylic acid and includes saturated fatty acids, unsaturated fatty acids, long chain fatty acids, medium chain fatty acids, short chain fatty acids, fatty acid precursors (including omega-9 fatty acid precursors), and esterified fatty acids. As used herein, “long chain polyunsaturated fatty acid” refers to any polyunsaturated carboxylic acid or organic acid with a long aliphatic tail. As used herein,

"omega-3 fatty acid" refers to any polyunsaturated fatty acid having a first double bond as the third carbon-carbon bond from the terminal methyl end of its carbon chain. In particular embodiments, the omega-3 fatty acid may comprise a long chain omega-3 fatty acid. As used herein, "omega-6 fatty acid" any polyunsaturated fatty acid having a first double bond as the sixth carbon-carbon bond from the terminal methyl end of its carbon chain.

Suitable omega-3 fatty acids for use in embodiments of the present invention can be derived from algae, fish, animals, plants, or combinations thereof, for example. Examples of suitable omega-3 fatty acids include, but are not limited to, linolenic acid, alpha-linolenic acid, eicosapentaenoic acid, docosahexaenoic acid, stearidonic acid, eicosatetraenoic acid and combinations thereof. In some embodiments, suitable omega-3 fatty acids can be provided in fish oils, (e.g., menhaden oil, tuna oil, salmon oil, bonito oil, and cod oil), microalgae omega-3 oils or combinations thereof. In particular embodiments, suitable omega-3 fatty acids may be derived from commercially available omega-3 fatty acid oils such as Microalgae DHA oil (from Martek, Columbia, MD), OmegaPure (from Omega Protein, Houston, TX), Marinol C-38 (from Lipid Nutrition, Channahon, IL), Bonito oil and MEG-3 (from Ocean Nutrition, Dartmouth, NS), Evogel (from Symrise, Holzminden, Germany), Marine Oil, from tuna or salmon (from Arista Wilton, CT), OmegaSource 2000, Marine Oil, from menhaden and Marine Oil, from cod (from OmegaSource, RTP, NC).

Suitable omega-6 fatty acids include, but are not limited to, linoleic acid, gamma-linolenic acid, dihommo-gamma-linolenic acid, arachidonic acid, eicosadienoic acid, docosadienoic acid, adrenic acid, docosapentaenoic acid and combinations thereof.

Suitable esterified fatty acids for embodiments of the present invention include, but are not limited to, monoacylgycerols containing omega-3 and/or omega-6 fatty acids, diacylgycerols containing omega-3 and/or omega-6 fatty acids, or triacylgycerols containing omega-3 and/or omega-6 fatty acids and combinations thereof.

In certain embodiments, the functional ingredient is glucosamine, optionally further comprising chondroitin sulfate.

In certain embodiments, the functional ingredient is at least one preservative. In particular embodiments, the preservative is chosen from antimicrobials, antioxidants, antienzymatics or combinations thereof. Non-limiting examples of antimicrobials include sulfites, propionates, benzoates, sorbates, nitrates, nitrites, bacteriocins, salts, sugars, acetic acid, dimethyl dicarbonate (DMDC), ethanol, and ozone. In one embodiment, the preservative is a sulfite. Sulfites include, but are not limited to, sulfur dioxide, sodium bisulfite, and

potassium hydrogen sulfite. In another embodiment, the preservative is a propionate. Propionates include, but are not limited to, propionic acid, calcium propionate, and sodium propionate. In yet another embodiment, the preservative is a benzoate. Benzoates include, but are not limited to, sodium benzoate and benzoic acid. In still another embodiment, the preservative is a sorbate. Sorbates include, but are not limited to, potassium sorbate, sodium sorbate, calcium sorbate, and sorbic acid. In a still further embodiment, the preservative is a nitrate and/or a nitrite. Nitrates and nitrites include, but are not limited to, sodium nitrate and sodium nitrite. In another embodiment, the at least one preservative is a bacteriocin, such as, for example, nisin. In still another embodiment, the preservative is ethanol. In yet another embodiment, the preservative is ozone. Non-limiting examples of antienzymatics suitable for use as preservatives in particular embodiments of the invention include ascorbic acid, citric acid, and metal chelating agents such as ethylenediaminetetraacetic acid (EDTA).

In certain embodiments, the functional ingredient is at least one hydration agent. In another particular embodiment, the hydration agent is a carbohydrate to supplement energy stores burned by muscles. Suitable carbohydrates for use in particular embodiments of this invention are described in U.S. Patent Numbers 4,312,856, 4,853,237, 5,681,569, and 6,989,171. Non-limiting examples of suitable carbohydrates include monosaccharides, disaccharides, oligosaccharides, complex polysaccharides or combinations thereof. Non-limiting examples of suitable types of monosaccharides for use in particular embodiments include trioses, tetroses, pentoses, hexoses, heptoses, octoses, and nonoses. Non-limiting examples of specific types of suitable monosaccharides include glyceraldehyde, dihydroxyacetone, erythrose, threose, erythrulose, arabinose, lyxose, ribose, xylose, ribulose, xylulose, allose, altrose, galactose, glucose, gulose, idose, mannose, talose, fructose, psicose, sorbose, tagatose, mannoheptulose, sedoheltulose, octolose, and sialose. Non-limiting examples of suitable disaccharides include sucrose, lactose, and maltose. Non-limiting examples of suitable oligosaccharides include saccharose, maltotriose, and maltodextrin. In other particular embodiments, the carbohydrates are provided by a corn syrup, a beet sugar, a cane sugar, a juice, or a tea.

In another particular embodiment, the hydration agent is a flavanol that provides cellular rehydration. Flavanols are a class of natural substances present in plants, and generally comprise a 2-phenylbenzopyrone molecular skeleton attached to one or more chemical moieties. Non-limiting examples of suitable flavanols for use in particular embodiments of this invention include catechin, epicatechin, gallocatechin, epigallocatechin, epicatechin gallate, epigallocatechin 3-gallate, theaflavin, theaflavin 3-gallate, theaflavin 3'-gallate, theaflavin 3,3' gallate, thearubigin or combinations thereof. Several common sources

of flavanols include tea plants, fruits, vegetables, and flowers. In preferred embodiments, the flavanol is extracted from green tea.

In a particular embodiment, the hydration agent is a glycerol solution to enhance exercise endurance. The ingestion of a glycerol containing solution has been shown to provide beneficial physiological effects, such as expanded blood volume, lower heart rate, and lower rectal temperature.

In certain embodiments, the functional ingredient is chosen from at least one probiotic, prebiotic and combination thereof. The probiotic is a beneficial microorganism that affects the human body's naturally-occurring gastrointestinal microflora. Examples of probiotics include, but are not limited to, bacteria of the genus *Lactobacilli*, *Bifidobacteria*, *Streptococci*, or combinations thereof, that confer beneficial effects to humans. In particular embodiments of the invention, the at least one probiotic is chosen from the genus *Lactobacilli*. According to other particular embodiments of this invention, the probiotic is chosen from the genus *Bifidobacteria*. In a particular embodiment, the probiotic is chosen from the genus *Streptococcus*.

Probiotics that may be used in accordance with this invention are well-known to those of skill in the art. Non-limiting examples of foodstuffs comprising probiotics include yogurt, sauerkraut, kefir, kimchi, fermented vegetables, and other foodstuffs containing a microbial element that beneficially affects the host animal by improving the intestinal microbalance.

Prebiotics, in accordance with the embodiments of this invention, include, without limitation, mucopolysaccharides, oligosaccharides, polysaccharides, amino acids, vitamins, nutrient precursors, proteins and combinations thereof. According to a particular embodiment of this invention, the prebiotic is chosen from dietary fibers, including, without limitation, polysaccharides and oligosaccharides. Non-limiting examples of oligosaccharides that are categorized as prebiotics in accordance with particular embodiments of this invention include fructooligosaccharides, inulins, isomalto-oligosaccharides, lactilol, lactosucrose, lactulose, pyrodextrins, soy oligosaccharides, transgalacto-oligosaccharides, and xylo-oligosaccharides. In other embodiments, the prebiotic is an amino acid. Although a number of known prebiotics break down to provide carbohydrates for probiotics, some probiotics also require amino acids for nourishment.

Prebiotics are found naturally in a variety of foods including, without limitation, bananas, berries, asparagus, garlic, wheat, oats, barley (and other whole grains), flaxseed, tomatoes, Jerusalem artichoke, onions and chicory, greens (e.g., dandelion greens, spinach,

collard greens, chard, kale, mustard greens, turnip greens), and legumes (e.g., lentils, kidney beans, chickpeas, navy beans, white beans, black beans).

In certain embodiments, the functional ingredient is at least one weight management agent. As used herein, "a weight management agent" includes an appetite suppressant and/or a thermogenesis agent. As used herein, the phrases "appetite suppressant", "appetite satiation compositions", "satiety agents", and "satiety ingredients" are synonymous. The phrase "appetite suppressant" describes macronutrients, herbal extracts, exogenous hormones, anorectics, anorexigenics, pharmaceutical drugs, and combinations thereof, that when delivered in an effective amount, suppress, inhibit, reduce, or otherwise curtail a person's appetite. The phrase "thermogenesis agent" describes macronutrients, herbal extracts, exogenous hormones, anorectics, anorexigenics, pharmaceutical drugs, and combinations thereof, that when delivered in an effective amount, activate or otherwise enhance a person's thermogenesis or metabolism.

Suitable weight management agents include macronutrients selected from the group consisting of proteins, carbohydrates, dietary fats, and combinations thereof. Consumption of proteins, carbohydrates, and dietary fats stimulates the release of peptides with appetite-suppressing effects. For example, consumption of proteins and dietary fats stimulates the release of the gut hormone cholecytokinin (CCK), while consumption of carbohydrates and dietary fats stimulates release of Glucagon-like peptide 1 (GLP-1).

Suitable macronutrient weight management agents also include carbohydrates. Carbohydrates generally comprise sugars, starches, cellulose and gums that the body converts into glucose for energy. Carbohydrates often are classified into two categories, digestible carbohydrates (e.g., monosaccharides, disaccharides, and starch) and non-digestible carbohydrates (e.g., dietary fiber). Studies have shown that non-digestible carbohydrates and complex polymeric carbohydrates having reduced absorption and digestibility in the small intestine stimulate physiologic responses that inhibit food intake. Accordingly, the carbohydrates embodied herein desirably comprise non-digestible carbohydrates or carbohydrates with reduced digestibility. Non-limiting examples of such carbohydrates include polydextrose; inulin; monosaccharide-derived polyols such as erythritol, mannitol, xylitol, and sorbitol; disaccharide-derived alcohols such as isomalt, lactitol, and maltitol; and hydrogenated starch hydrolysates. Carbohydrates are described in more detail herein below.

In another particular embodiment, the weight management agent is a dietary fat. Dietary fats are lipids comprising combinations of saturated and unsaturated fatty acids.

Polyunsaturated fatty acids have been shown to have a greater satiating power than mono-unsaturated fatty acids. Accordingly, the dietary fats embodied herein desirably comprise poly-unsaturated fatty acids, non-limiting examples of which include triacylglycerols.

In another particular embodiment, the weight management agent is an herbal extract. Extracts from numerous types of plants have been identified as possessing appetite suppressant properties. Non-limiting examples of plants whose extracts have appetite suppressant properties include plants of the genus *Hoodia*, *Trichocaulon*, *Caralluma*, *Stapelia*, *Orbea*, *Asclepias*, and *Camelia*. Other embodiments include extracts derived from Gymnema Sylvestre, Kola Nut, Citrus Auran tium, Yerba Mate, Griffonia Simplicifolia, Guarana, myrrh, guggul Lipid, and black current seed oil.

The herbal extracts may be prepared from any type of plant material or plant biomass. Non-limiting examples of plant material and biomass include the stems, roots, leaves, dried powder obtained from the plant material, and sap or dried sap. The herbal extracts generally are prepared by extracting sap from the plant and then spray-drying the sap. Alternatively, solvent extraction procedures may be employed. Following the initial extraction, it may be desirable to further fractionate the initial extract (e.g., by column chromatography) in order to obtain an herbal extract with enhanced activity. Such techniques are well known to those of ordinary skill in the art.

In one embodiment, the herbal extract is derived from a plant of the genus *Hoodia*. A sterol glycoside of *Hoodia*, known as P57, is believed to be responsible for the appetite-suppressant effect of the *Hoodia* species. In another embodiment, the herbal extract is derived from a plant of the genus *Caralluma*, non-limiting examples of which include caratuberside A, caratuberside B, bouceroside I, bouceroside II, bouceroside III, bouceroside IV, bouceroside V, bouceroside VI, bouceroside VII, bouceroside VIII, bouceroside IX, and bouceroside X. In another embodiment, the at least one herbal extract is derived from a plant of the genus *Trichocaulon*. *Trichocaulon* plants are succulents that generally are native to southern Africa, similar to *Hoodia*, and include the species *T. piliferum* and *T. officinale*. In another embodiment, the herbal extract is derived from a plant of the genus *Stapelia* or *Orbea*. Not wishing to be bound by any theory, it is believed that the compounds exhibiting appetite suppressant activity are saponins, such as pregnane glycosides, which include stavarosides A, B, C, D, E, F, G, H, I, J, and K. In another embodiment, the herbal extract is derived from a plant of the genus *Asclepias*. Not wishing to be bound by any theory, it is believed that the extracts comprise steroidal compounds, such as pregnane glycosides and pregnane aglycone, having appetite suppressant effects.

In another particular embodiment, the weight management agent is an exogenous hormone having a weight management effect. Non-limiting examples of such hormones include CCK, peptide YY, ghrelin, bombesin and gastrin-releasing peptide (GRP), enterostatin, apolipoprotein A-IV, GLP-1, amylin, somastatin, and leptin.

In another embodiment, the weight management agent is a pharmaceutical drug. Non-limiting examples include phentenime, diethylpropion, phendimetrazine, sibutramine, rimonabant, oxyntomodulin, floxetine hydrochloride, ephedrine, phenethylamine, or other stimulants.

In certain embodiments, the functional ingredient is at least one osteoporosis management agent. In certain embodiments, the osteoporosis management agent is at least one calcium source. According to a particular embodiment, the calcium source is any compound containing calcium, including salt complexes, solubilized species, and other forms of calcium. Non-limiting examples of calcium sources include amino acid chelated calcium, calcium carbonate, calcium oxide, calcium hydroxide, calcium sulfate, calcium chloride, calcium phosphate, calcium hydrogen phosphate, calcium dihydrogen phosphate, calcium citrate, calcium malate, calcium citrate malate, calcium gluconate, calcium tartrate, calcium lactate, solubilized species thereof, and combinations thereof.

According to a particular embodiment, the osteoporosis management agent is a magnesium soucrce. The magnesium source is any compound containing magnesium, including salt complexes, solubilized species, and other forms of magnesium. Non-limiting examples of magnesium sources include magnesium chloride, magnesium citrate, magnesium gluceptate, magnesium gluconate, magnesium lactate, magnesium hydroxide, magnesium picolate, magnesium sulfate, solubilized species thereof, and mixtures thereof. In another particular embodiment, the magnesium source comprises an amino acid chelated or creatine chelated magnesium.

In other embodiments, the osteoporosis agent is chosen from vitamins D, C, K, their precursors and/or beta-carotene and combinations thereof.

Numerous plants and plant extracts also have been identified as being effective in the prevention and treatment of osteoporosis. Non-limiting examples of suitable plants and plant extracts as osteoporosis management agents include species of the genus *Taraxacum* and *Amelanchier*, as disclosed in U.S. Patent Publication No. 2005/0106215, and species of the genus *Lindera*, *Artemisia*, *Acorus*, *Carthamus*, *Carum*, *Cnidium*, *Curcuma*, *Cyperus*, *Juniperus*, *Prunus*, *Iris*, *Cichorium*, *Dodonaea*, *Epimedium*, *Erigonoum*, *Soya*, *Mentha*,

Ocimum, *thymus*, *Tanacetum*, *Plantago*, *Spearmint*, *Bixa*, *Vitis*, *Rosemarinus*, *Rhus*, and *Anethum*, as disclosed in U.S. Patent Publication No. 2005/0079232.

In certain embodiments, the functional ingredient is at least one phytoestrogen. Phytoestrogens are compounds found in plants which can typically be delivered into human bodies by ingestion of the plants or the plant parts having the phytoestrogens. As used herein, "phytoestrogen" refers to any substance which, when introduced into a body causes an estrogen-like effect of any degree. For example, a phytoestrogen may bind to estrogen receptors within the body and have a small estrogen-like effect.

Examples of suitable phytoestrogens for embodiments of this invention include, but are not limited to, isoflavones, stilbenes, lignans, resorcyclic acid lactones, coumestans, coumestrol, equol, and combinations thereof. Sources of suitable phytoestrogens include, but are not limited to, whole grains, cereals, fibers, fruits, vegetables, black cohosh, agave root, black currant, black haw, chasteberries, cramp bark, dong quai root, devil's club root, false unicorn root, ginseng root, groundsel herb, licorice, liferoot herb, motherwort herb, peony root, raspberry leaves, rose family plants, sage leaves, sarsaparilla root, saw palmetto berried, wild yam root, yarrow blossoms, legumes, soybeans, soy products (e.g., miso, soy flour, soymilk, soy nuts, soy protein isolate, tempen, or tofu) chick peas, nuts, lentils, seeds, clover, red clover, dandelion leaves, dandelion roots, fenugreek seeds, green tea, hops, red wine, flaxseed, garlic, onions, linseed, borage, butterfly weed, caraway, chaste tree, vitex, dates, dill, fennel seed, gotu kola, milk thistle, pennyroyal, pomegranates, southernwood, soya flour, tansy, and root of the kudzu vine (pueraria root) and the like, and combinations thereof.

Isoflavones belong to the group of phytonutrients called polyphenols. In general, polyphenols (also known as "polyphenolics"), are a group of chemical substances found in plants, characterized by the presence of more than one phenol group per molecule.

Suitable phytoestrogen isoflavones in accordance with embodiments of this invention include genistein, daidzein, glycitein, biochanin A, formononetin, their respective naturally occurring glycosides and glycoside conjugates, matairesinol, secoisolariciresinol, enterolactone, enterodiol, textured vegetable protein, and combinations thereof.

Suitable sources of isoflavones for embodiments of this invention include, but are not limited to, soy beans, soy products, legumes, alfalfa sprouts, chickpeas, peanuts, and red clover.

In certain embodiments, the functional ingredient is at least one long chain primary aliphatic saturated alcohol. Long-chain primary aliphatic saturated alcohols are a diverse

group of organic compounds. The term alcohol refers to the fact these compounds feature a hydroxyl group (-OH) bound to a carbon atom. Non-limiting examples of particular long-chain primary aliphatic saturated alcohols for use in particular embodiments of the invention include the 8 carbon atom 1-octanol, the 9 carbon 1-nonanol, the 10 carbon atom 1-decanol, the 12 carbon atom 1-dodecanol, the 14 carbon atom 1-tetradecanol, the 16 carbon atom 1-hexadecanol, the 18 carbon atom 1-octadecanol, the 20 carbon atom l-eicosanol, the 22 carbon 1-docosanol, the 24 carbon 1-tetracosanol, the 26 carbon 1-hexacosanol, the 27 carbon 1-heptacosanol, the 28 carbon 1-octanosol, the 29 carbon 1-nonacosanol, the 30 carbon 1-triacontanol, the 32 carbon 1-dotriacontanol, and the 34 carbon 1-tetracontanol.

In one embodiment, the long-chain primary aliphatic saturated alcohol is a policosanol. Policosanol is the term for a mixture of long-chain primary aliphatic saturated alcohols composed primarily of 28 carbon 1-octanosol and 30 carbon 1-triacontanol, as well as other alcohols in lower concentrations such as 22 carbon 1-docosanol, 24 carbon 1-tetracosanol, 26 carbon 1-hexacosanol, 27 carbon 1-heptacosanol, 29 carbon 1-nonacosanol, 32 carbon 1-dotriacontanol, and 34 carbon 1-tetracontanol.

In certain embodiments, the functional ingredient is at least one phytosterol, phytostanol or combination thereof. As used herein, the phrases “stanol”, “plant stanol” and “phytostanol” are synonymous. Plant sterols and stanols are present naturally in small quantities in many fruits, vegetables, nuts, seeds, cereals, legumes, vegetable oils, bark of the trees and other plant sources. Sterols are a subgroup of steroids with a hydroxyl group at C-3. Generally, phytosterols have a double bond within the steroid nucleus, like cholesterol; however, phytosterols also may comprise a substituted side chain (R) at C-24, such as an ethyl or methyl group, or an additional double bond. The structures of phytosterols are well known to those of skill in the art.

At least 44 naturally-occurring phytosterols have been discovered, and generally are derived from plants, such as corn, soy, wheat, and wood oils; however, they also may be produced synthetically to form compositions identical to those in nature or having properties similar to those of naturally-occurring phytosterols. Non-limiting suitable phytosterols include, but are not limited to, 4-desmethylsterols (e.g., β-sitosterol, campesterol, stigmasterol, brassicasterol, 22-dehydrobrassicasterol, and Δ5-avenasterol), 4-monomethyl sterols, and 4,4-dimethyl sterols (triterpene alcohols) (e.g., cycloartenol, 24-methylenecycloartanol, and cyclobranol).

As used herein, the phrases “stanol”, “plant stanol” and “phytostanol” are synonymous. Phytostanols are saturated sterol alcohols present in only trace amounts in nature and also

may be synthetically produced, such as by hydrogenation of phytosterols. Suitable phytostanols include, but are not limited to, β-sitostanol, campestanol, cycloartanol, and saturated forms of other triterpene alcohols.

Both phytosterols and phytostanols, as used herein, include the various isomers such as the α and β isomers. The phytosterols and phytostanols of the present invention also may be in their ester form. Suitable methods for deriving the esters of phytosterols and phytostanols are well known to those of ordinary skill in the art, and are disclosed in U.S. Patent Numbers 6,589,588, 6,635,774, 6,800,317, and U.S. Patent Publication Number 2003/0045473. Non-limiting examples of suitable phytosterol and phytostanol esters include sitosterol acetate, sitosterol oleate, stigmasterol oleate, and their corresponding phytostanol esters. The phytosterols and phytostanols of the present invention also may include their derivatives.

C. Additives

The juice beverages described herein can further include at least one additive. Exemplary additives include, but not limited to, carbohydrates, polyols, amino acids and their corresponding salts, poly-amino acids and their corresponding salts, sugar acids and their corresponding salts, nucleotides, organic acids, inorganic acids, bitter compounds, caffeine, flavorants and flavoring ingredients, astringent compounds, proteins or protein hydrolysates, surfactants, emulsifiers, plant extracts, flavonoids, alcohols, polymers and combinations thereof.

The term "polyol", as used herein, refers to a molecule that contains more than one hydroxyl group. A polyol may be a diol, triol, or a tetraol which contains 2, 3, and 4 hydroxyl groups respectively. A polyol also may contain more than 4 hydroxyl groups, such as a pentaol, hexaol, heptaol, or the like, which contain 5, 6, or 7 hydroxyl groups, respectively. Additionally, a polyol also may be a sugar alcohol, polyhydric alcohol, or polyalcohol which is a reduced form of carbohydrate, wherein the carbonyl group (aldehyde or ketone, reducing sugar) has been reduced to a primary or secondary hydroxyl group. Non-limiting examples of polyols in some embodiments include maltitol, mannitol, sorbitol, lactitol, xylitol, isomalt, propylene glycol, glycerol (glycerin), threitol, galactitol, palatinose, reduced isomalto-oligosaccharides, reduced xylo-oligosaccharides, reduced gentio-oligosaccharides, reduced maltose syrup, reduced glucose syrup, and sugar alcohols or any other carbohydrates capable of being reduced which do not adversely affect taste.

Suitable amino acid additives include, but are not limited to, aspartic acid, arginine, glycine, glutamic acid, proline, threonine, theanine, cysteine, cystine, alanine, valine, tyrosine, leucine, arabinose, trans-4-hydroxyproline, isoleucine, asparagine, serine, lysine, histidine,

ornithine, methionine, carnitine, aminobutyric acid (α–, β–, and/or δ-isomers), glutamine, hydroxyproline, taurine, norvaline, sarcosine, and their salt forms such as sodium or potassium salts or acid salts. The amino acid additives also may be in the D- or L-configuration and in the mono-, di-, or tri-form of the same or different amino acids. Additionally, the amino acids may be α-, β-, γ- and/or δ-isomers if appropriate. Combinations of the foregoing amino acids and their corresponding salts (*e.g.*, sodium, potassium, calcium, magnesium salts or other alkali or alkaline earth metal salts thereof, or acid salts) also are suitable additives in some embodiments. The amino acids may be natural or synthetic. The amino acids also may be modified. Modified amino acids refers to any amino acid wherein at least one atom has been added, removed, substituted, or combinations thereof (*e.g.*, N-alkyl amino acid, N-acyl amino acid, or N-methyl amino acid). Non-limiting examples of modified amino acids include amino acid derivatives such as trimethyl glycine, N-methyl-glycine, and N-methyl-alanine. As used herein, modified amino acids encompass both modified and unmodified amino acids. As used herein, amino acids also encompass both peptides and polypeptides (*e.g.*, dipeptides, tripeptides, tetrapeptides, and pentapeptides) such as glutathione and L-alanyl-L-glutamine.

Suitable polyamino acid additives include poly-L-aspartic acid, poly-L-lysine (e.g., poly-L-α-lysine or poly-L-ε-lysine), poly-L-ornithine (*e.g.*, poly-L-α-ornithine or poly-L-ε-ornithine), poly-L-arginine, other polymeric forms of amino acids, and salt forms thereof (*e.g.*, calcium, potassium, sodium, or magnesium salts such as L-glutamic acid mono sodium salt). The poly-amino acid additives also may be in the D- or L-configuration. Additionally, the poly-amino acids may be α-, β-, γ-, δ-, and ε-isomers if appropriate. Combinations of the foregoing poly-amino acids and their corresponding salts (*e.g.*, sodium, potassium, calcium, magnesium salts or other alkali or alkaline earth metal salts thereof or acid salts) also are suitable additives in some embodiments. The poly-amino acids described herein also may comprise co-polymers of different amino acids. The poly-amino acids may be natural or synthetic. The poly-amino acids also may be modified, such that at least one atom has been added, removed, substituted, or combinations thereof (e.g., N-alkyl poly-amino acid or N-acyl poly-amino acid). As used herein, poly-amino acids encompass both modified and unmodified poly-amino acids. For example, modified poly-amino acids include, but are not limited to, poly-amino acids of various molecular weights (MW), such as poly-L-α-lysine with a MW of 1,500, MW of 6,000, MW of 25,200, MW of 63,000, MW of 83,000, or MW of 300,000.

Suitable sugar acid additives include, but are not limited to, aldonic, uronic, aldaric, alginic, gluconic, glucuronic, glucaric, galactaric, galacturonic, and salts thereof (e.g., sodium, potassium, calcium, magnesium salts or other physiologically acceptable salts), and combinations thereof.

Suitable nucleotide additives include, but are not limited to, inosine monophosphate ("IMP"), guanosine monophosphate ("GMP"), adenosine monophosphate ("AMP"), cytosine monophosphate (CMP), uracil monophosphate (UMP), inosine diphosphate, guanosine diphosphate, adenosine diphosphate, cytosine diphosphate, uracil diphosphate, inosine triphosphate, guanosine triphosphate, adenosine triphosphate, cytosine triphosphate, uracil triphosphate, alkali or alkaline earth metal salts thereof, and combinations thereof. The nucleotides described herein also may comprise nucleotide-related additives, such as nucleosides or nucleic acid bases (*e.g.*, guanine, cytosine, adenine, thymine, uracil).

Suitable organic acid additives include any compound which comprises a -COOH moiety, such as, for example, C2-C30 carboxylic acids, substituted hydroxyl C2-C30 carboxylic acids, butyric acid (ethyl esters), substituted butyric acid (ethyl esters), benzoic acid, substituted benzoic acids (*e.g.*, 2,4-dihydroxybenzoic acid), substituted cinnamic acids, hydroxyacids, substituted hydroxybenzoic acids, anisic acid substituted cyclohexyl carboxylic acids, tannic acid, aconitic acid, lactic acid, tartaric acid, citric acid, isocitric acid, gluconic acid, glucoheptonic acids, adipic acid, hydroxycitric acid, malic acid, fruitaric acid (a blend of malic, fumaric, and tartaric acids), fumaric acid, maleic acid, succinic acid, chlorogenic acid, salicylic acid, creatine, caffeic acid, bile acids, acetic acid, ascorbic acid, alginic acid, erythorbic acid, polyglutamic acid, glucono delta lactone, and their alkali or alkaline earth metal salt derivatives thereof. In addition, the organic acid additives also may be in either the D- or L-configuration.

Suitable bitter compound additives include, but are not limited to, caffeine, quinine, urea, bitter orange oil, naringin, quassia, and salts thereof.

Suitable flavorants and flavoring ingredient additives include, but are not limited to, vanillin, vanilla extract, mango extract, cinnamon, citrus, coconut, ginger, viridiflorol, almond, menthol (including menthol without mint), grape skin extract, and grape seed extract. “Flavorant” and “flavoring ingredient” are synonymous and can include natural or synthetic substances or combinations thereof. Flavorants also include any other substance which imparts flavor and may include natural or non-natural (synthetic) substances which are safe for human or animals when used in a generally accepted range. Non-limiting examples of proprietary flavorants include Döhler™ Natural Flavoring Sweetness Enhancer K14323 (Döhler™, Darmstadt, Germany), Symrise™ Natural Flavor Mask for Sweeteners 161453 and 164126 (Symrise™, Holzminden, Germany), Natural Advantage™ Bitterness Blockers 1, 2, 9 and 10 (Natural Advantage™, Freehold, New Jersey, U.S.A.), and Sucramask™ (Creative Research Management, Stockton, California, U.S.A.).

Suitable polymer additives include, but are not limited to, chitosan, pectin, pectic, pectinic, polyuronic, polygalacturonic acid, starch, food hydrocolloid or crude extracts thereof (e.g., gum acacia senegal (Fibergum™), gum acacia seyal, carageenan), poly-L-lysine (e.g., poly-L-α-lysine or poly-L-ε-lysine), poly-L-ornithine (e.g., poly-L-α-ornithine or poly-L-ε-ornithine), polypropylene glycol, polyethylene glycol, poly(ethylene glycol methyl ether), polyarginine, polyaspartic acid, polyglutamic acid, polyethylene imine, alginic acid, sodium alginate, propylene glycol alginate, and sodium polyethyleneglycolalginate, sodium hexametaphosphate and its salts, and other cationic polymers and anionic polymers.

Suitable protein or protein hydrolysate additives include, but are not limited to, bovine serum albumin (BSA), whey protein (including fractions or concentrates thereof such as 90% instant whey protein isolate, 34% whey protein, 50% hydrolyzed whey protein, and 80% whey protein concentrate), soluble rice protein, soy protein, protein isolates, protein hydrolysates, reaction products of protein hydrolysates, glycoproteins, and/or proteoglycans containing amino acids (e.g., glycine, alanine, serine, threonine, asparagine, glutamine, arginine, valine, isoleucine, leucine, norvaline, methionine, proline, tyrosine, hydroxyproline, and the like), collagen (e.g., gelatin), partially hydrolyzed collagen (e.g., hydrolyzed fish collagen), and collagen hydrolysates (e.g., porcine collagen hydrolysate).

Suitable surfactant additives include, but are not limited to, polysorbates (e.g., polyoxyethylene sorbitan monooleate (polysorbate 80), polysorbate 20, polysorbate 60), sodium dodecylbenzenesulfonate, dioctyl sulfosuccinate or dioctyl sulfosuccinate sodium, sodium dodecyl sulfate, cetylpyridinium chloride (hexadecylpyridinium chloride), hexadecyltrimethylammonium bromide, sodium cholate, carbamoyl, choline chloride, sodium glycocholate, sodium taurodeoxycholate, lauric arginate, sodium stearoyl lactylate, sodium taurocholate, lecithins, sucrose oleate esters, sucrose stearate esters, sucrose palmitate esters, sucrose laurate esters, and other emulsifiers, and the like.

Suitable flavonoid additives are classified as flavonols, flavones, flavanones, flavan-3-ols, isoflavones, or anthocyanidins. Non-limiting examples of flavonoid additives include, but are not limited to, catechins (e.g., green tea extracts such as Polyphenon™ 60, Polyphenon™ 30, and Polyphenon™ 25 (Mitsui Norin Co., Ltd., Japan), polyphenols, rutins (e.g., enzyme modified rutin Sanmelin™ AO (San-fi Gen F.F.I., Inc., Osaka, Japan)), neohesperidin, naringin, neohesperidin dihydrochalcone, and the like.

Suitable alcohol additives include, but are not limited to, ethanol.

Suitable astringent compound additives include, but are not limited to, tannic acid, europium chloride ($EuCl_3$), gadolinium chloride ($GdCl_3$), terbium chloride ($TbCl_3$), alum, tannic acid, and polyphenols (e.g., tea polyphenols).

III. Methods

Methods of preparing the reduced calorie juice beverages of the present invention are also provided.

In one embodiment, a method of preparing a reduced calorie juice beverage comprises combining (i) at least one juice; (ii) at least one high potency sweetener; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

In another embodiment, a method of preparing a reduced calorie juice beverage comprises combining (i) at least one juice selected from the group consisting of juices of citrus fruit (e.g., orange, grapefruit, lemon, lime, tangerine, tangelo), apricot, apple, kumquat, mango, pear, peach, pineapple, papaya, passion fruit, grape, strawberry, raspberry, cranberry, currant, bean, blueberry, blackberry, acai, lychee, kiwi, pomegranate, watermelon, rhubarb, aronia, tomato, celery, cucurbits, onion, watercress, cucumber, carrot, parsley, beet, asparagus, potato, turnip, rutabaga, and combinations thereof; (ii) at least one high potency sweetener; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage can comprise juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

In a more particular embodiment, a method of preparing a reduced calorie juice beverage comprises combining (i) at least one juice selected from the group consisting of juices of citrus fruit (e.g., orange, grapefruit, lemon, lime, tangerine, tangelo), apricot, apple, kumquat, mango, pear, peach, pineapple, papaya, passion fruit, grape, strawberry, raspberry, cranberry, currant, bean, blueberry, blackberry, acai, lychee, kiwi, pomegranate, watermelon, rhubarb, aronia, tomato, celery, cucurbits, onion, watercress, cucumber, carrot, parsley, beet, asparagus, potato, turnip, rutabaga, and combinations thereof; (ii) at least one high potency

sweetener selected from the group consisting of rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, rebaudioside B, monk fruit juice or concentrate, monk fruit extract, siamenoside I, mogroside V, thaumatin (and variants thereof), brazzein (and variants thereof), monellin (and variants thereof), sweet truffle protein (and variants thereof), sucralose, potassium acesulfame, aspartame, saccharin, cyclamate, and combinations thereof; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The juice beverage comprises juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The juice beverage comprises the at least one high potency sweetener in an amount from about 1 ppm to about 600 ppm, as discussed above. The juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

In a particular embodiment, a method for preparing a reduced calorie orange juice beverage comprises combining (i) orange juice; (ii) at least one high potency sweetener selected from the group consisting of rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, rebaudioside B, monk fruit juice or concentrate, monk fruit extract, siamenoside I, mogroside V, thaumatin (and variants thereof), brazzein (and variants thereof), monellin (and variants thereof), sweet truffle protein (and variants thereof), sucralose, potassium acesulfame, aspartame, saccharin, cyclamate, and combinations thereof; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The orange juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The orange juice beverage comprises the at least one high potency sweetener in an amount from about 1 ppm to about 600 ppm, as discussed above. The orange juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

In a more particular embodiment, a method for preparing a reduced calorie orange juice beverage comprises combining (i) orange juice; (ii) at least one high potency sweetener comprising rebaudioside A; and (iii) at least one salt selected from the group consisting of

sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The orange juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The orange juice beverage comprises rebaudioside A in an amount from about 25 to about 600 ppm, or about 100 ppm to about 300 ppm, as discussed above. The orange juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

In another more particular embodiment, a method for preparing a reduced calorie orange juice beverage comprises combining (i) orange juice; (ii) at least one high potency sweetener that is a steviol glycoside mixture comprising at least about 95% rebaudioside A by weight on a dry basis; and (iii at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The orange juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The orange juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or about 100 ppm to about 300 ppm, as discussed above. The orange juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

Alternatively, a method for preparing a reduced calorie orange juice beverage comprises combining (i) orange juice; (ii) at least one high potency sweetener comprising a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The orange juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The orange juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or from about 100 ppm to about 300 ppm, as discussed above. The orange juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above. The method can further comprise combining (iv) water. The method

can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

In another embodiment, a method for preparing reduced calorie orange juice beverage comprises combining (i) orange juice; (ii) at least one high potency sweetener comprising a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The orange juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The orange juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600 ppm, as discussed above. The orange juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

In still another embodiment, a method for preparing a reduced calorie orange juice beverage comprises combining (i) orange juice; (ii) at least one high potency sweetener comprising two steviol glycoside mixtures: the first steviol glycoside mixture containing at least about 95% rebaudioside A by weight on a dry basis and the second steviol glycoside mixture containing at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis; and (iii) at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate. The orange juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The orange juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or about 300 ppm to about 300 ppm, as discussed above. The orange juice beverage comprises the at least one salt in an amount from about 250 ppm to about 500 ppm, as discussed above. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

In a more particular embodiment, a method for preparing reduced calorie orange juice beverage comprises combining (i) orange juice; (ii) at least one high potency sweetener

comprising two steviol glycoside mixtures: the first steviol glycoside mixture containing at least about 95% rebaudioside A by weight on a dry basis and the second steviol glycoside mixture containing at least about 50% rebaudioside A by weight on a dry basis and at least about 30% rebaudioside B by weight on a dry basis; and (iii) at least one salt selected from sodium gluconate and potassium gluconate. The orange juice beverage comprises orange juice in an amount from about 10% to about 90% by weight, e.g., from about 40% to about 60% by weight, as discussed above. The orange juice beverage comprises the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or about 100 ppm to about 300 ppm, as discussed above. The orange juice beverage comprises the salt in an amount from about 250 ppm to about 500 ppm, more preferably from about 400 ppm to about 500 ppm, as discussed above. The method can further comprise combining (iv) water. The method can further comprise combining (v) pulp, (vi) at least one natural flavor, and/or at (vii) least one organic acid. All of the components and their respective amounts in the juice beverage are described above.

Methods of preparing juice beverages are known in the art and include combining all ingredients and the pasteurized the resulting mixture. The pasteurized mixture is then cooled to, e.g., 4 °C.

EXAMPLES

Materials and Methods

Commercial stevia extracts (rebaudioside-A 95% purity; blend of rebaudioside-A 55% and rebaudioside-B 30%) were used to sweeten the base, on top of the orange juice. Food grade salts with high purity (>95%) were acquired from different suppliers.

Table 1. Compounds Used and Maximum Levels in Beverages

Ingredients	MAX USED (ppm)
Tri-calcium citrate tetrahydrate	140
Calcium lactate pentahydrate	140
Magnesium lactate dihydrate	406
Sodium gluconate	460
Tri-potassium citrate	300
Potassium lactate	300
Potassium gluconate	460

Reduced calorie Orange Juice Beverage

The ingredients in Table 2 were dissolved in filtered water to complete dissolution and the beverages were pasteurized (88-90°C), filled in 300 ml PET bottles, then cooled in ice

water. Beverages were stored in 4°C and tasted cold. Beverage brix was 5.8° and titratable acidity was 0.56% w/v as citric acid. Orange juice content for beverages was 46.4% w/v.

Table 2 below shows the ingredients list for the control sample without organic salts. For Test samples (1-14) different organic salts were added on top of the control base sample in the amount (ppm) as shown in Tables 3 and 4.

Table 2. Reduced Calorie Orange Juice Beverage Composition

Ingredients	**Control (grams)**
Filtered water	51.368
Orange juice 11.8°Brix	46.38
Orange pulp 12° Brix	1.79
Citric acid	0.2189
Ascorbic acid	0.045
Pectin	0.07
Beta carotene 3%	0.006
Rebaudioside-A 95%	0.0085
Rebaudioside-A 55%	0.0085
Orange flavor	0.105
TOTAL (grams)	100

Table 3. Organic Salt Combinations – Lower Levels (Test Samples 1-7)

Ingredients	**Test 1 (ppm)**	**Test 2 (ppm)**	**Test 3 (ppm)**	**Test 4 (ppm)**	**Test 5 (ppm)**	**Test 6 (ppm)**	**Test 7 (ppm)**
Potassium citrate	150		75				
Potassium lactate		150	75				
Sodium gluconate				230			
Calcium citrate					70	70	
Calcium lactate					70		
Magnesium lactate						203	
Potassium gluconate							230

Table 4. Organic Salt Combinations – Higher Levels (Test Samples 8-14)

Ingredients	Test 8 (ppm)	Test 9 (ppm)	Test 10 (ppm)	Test 11 (ppm)	Test 12 (ppm)	Test 13 (ppm)	Test 14 (ppm)
Potassium citrate	300		150				
Potassium lactate		300	150				
Sodium gluconate				460			
Calcium citrate					140	140	
Calcium lactate					140		
Magnesium lactate						406	
Potassium gluconate							460

Sensory Evaluation

The beverages were evaluated blindly by six expert panelists. Samples were coded and randomly presented to the panelists. Panelists were instructed to eat an unsalted cracker and rinse the mouth with water before and in between samples. The maximum samples for each session was set at 6 samples to avoid fatigue. For each sample, panelists were instructed to take 3 sips, then write down their evaluation comments.

Sensory Results

Table 5. Orange Juice Beverages – Lower Organic Salts

Beverages with Salts and ppm levels	Panelists Comments
Control (no added organic salts)	More sweetness lingering, more bitter and licorice aftertaste, less orange flavor
Test 1	Sweeter compared to control, cleaner flavor, no sweet lingering aftertaste
Test 2	Sweeter compared to control, cleaner flavor, no sweet lingering aftertaste
Test 3	Preferred over Test 1 and Test 2 samples, sweeter than control, more rounded flavor, more mouthfeel compared to control

Test 4	Clean and refreshing flavor, sweeter than control sample, more balanced
Test 5	Dry end, harsh aftertaste, not different from control sample
Test 6	Dry ending, taste very close to Test 5
Test 7	Sweeter than control, balanced flavor

From above samples, Test 1, 2, 3, 4 and 7 were much preferred by panelists who thought that there was significant taste improvement. Test 5 and 6 were least preferred by panelists and thought to be close to the control sample.

Table 6. Orange Juice Beverages – Higher Organic Salts

Beverages with Salts and ppm levels	**Panelists Comments**
Control (no added organic salts)	More sweetness lingering, more bitter and licorice aftertaste, less orange flavor
Test 8	4th preference by panelists. Sweeter than control sample and flavor is refreshing, no off notes
Test 9	5th preference by panelists. Sweeter than control sample and good sweetness and flavor balance
Test 10 – K citrate and K lactate	3rd preference by panelists. Sweeter than control, nice orange flavor, no lingering off-notes
Test 11- Na gluconate	2nd preference by panelists. Fresh orange flavor, sweeter than control sample.
Test 12	The organic salts improve the overall taste with much reduced off notes, but less preferred compared to other organic salts
Test 13	The organic salts improve the overall taste with much reduced off notes, but less preferred compared to other organic salts
Test 14 – K gluconate	Sample most preferred by panelists. The orange flavor is fresh, refreshing, with nice balance of sweet and flavor without any off notes.

Increasing organic salt concentrations significantly improved the overall taste by significantly reducing sweetness lingering, astringency and licorice aftertaste attributed to high

intensity sweeteners. The overall taste was more rounded with more mouthfeel and panelists preferred this set over the set with lower organic salt concentrations.

CLAIMS

1. A reduced calorie juice beverage comprising:
    i. at least one juice;
    ii. at least one high potency sweetener selected from the group consisting of rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, rebaudioside B, monk fruit juice or concentrate, monk fruit extract, siamenoside I, mogroside V, thaumatin (and variants thereof), brazzein (and variants thereof), monellin (and variants thereof), sweet truffle protein (and variants thereof), sucralose, potassium acesulfame, aspartame, saccharin, cyclamate, and combinations thereof; and
    iii. at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate.
2. The reduced calorie juice beverage of claim 1, wherein the at least one juice is selected from the group consisting of juices of citrus fruit (e.g., orange, grapefruit, lemon, lime, tangerine, tangelo), apricot, apple, kumquat, mango, pear, peach, pineapple, papaya, passion fruit, grape, strawberry, raspberry, cranberry, currant, bean, blueberry, blackberry, acai, lychee, kiwi, pomegranate, watermelon, rhubarb, aronia, tomato, celery, cucurbits, onion, watercress, cucumber, carrot, parsley, beet, asparagus, potato, turnip, rutabaga, and combinations thereof.
3. The reduced calorie juice beverage of claim 2, wherein the at least one juice is present in the beverage in an amount from about 10% to about 90% by weight or from about 40% to about 60% by weight.
4. The reduced calorie juice beverage of claim 2, wherein the at least one juice is a citrus juice.
5. The reduced calorie juice beverage of claim 4, wherein the at least one juice is orange juice.
6. The reduced calorie juice beverage of claim 1, wherein the concentration of the at least one high potency sweetener is from about 1 ppm to about 600 ppm.
7. The reduced calorie juice beverage of claim 6, wherein the at least one high potency sweetener is rebaudioside A.
8. The reduced calorie juice beverage of claim 6, wherein the concentration of the at least one high potency sweetener is from about 25 to about 600 ppm.

9. The reduced calorie juice beverage of claim 1, wherein one or more of the following is true: (a) the beverage does not contain rebaudioside M or rebaudioside D, (b) the beverage does not contain rebaudioside M or rebaudioside D in an amount greater than about 1% by weight, greater than about 5% by weight, greater than about 10% by weight, or greater than 20% by weight or (c) the beverage does not contain a steviol glycoside mixture containing rebaudioside M or rebaudioside D in an amount greater than about 1% by weight on a dry basis, greater than about 5% by weight on a dry basis, or greater than about 10% by weight on a dry basis.

10. The reduced calorie juice beverage of claim 1, wherein the beverage does not contain added caloric sweeteners.

11. The reduced calorie juice beverage of claim 1, wherein the at least one salt is present in a concentration from about 250 ppm to about 500 ppm.

12. The reduced calorie juice beverage of claim 11, wherein the at least one salt is potassium gluconate or sodium gluconate.

13. The reduced calorie juice beverage of claim 1, wherein the beverage does not contain potassium, sodium, calcium, or magnesium salts of inorganic ions and/or does not contain magnesium or calcium salts of gluconate, citrate or lactate.

14. The reduced calorie juice beverage of claim 1, further comprising at least one of the following: water, pulp, natural flavor, organic acid, or a combination thereof.

15. The reduced calorie juice beverage of claim 1, wherein the pH is from about 3 to about 4.5.

16. The reduced calorie juice beverage of claim 1, wherein the Brix of the beverage is from 2 °Bx to about 7 °Bx.

17. A reduced calorie orange juice beverage comprising:

    i. orange juice;

    ii. at least one high potency sweetener selected from the group consisting of rebaudioside A, rebaudioside M, rebaudioside AM, rebaudioside E, rebaudioside N, rebaudioside B, monk fruit juice or concentrate, monk fruit extract, siamenoside I, mogroside V, thaumatin (and variants thereof), brazzein (and variants thereof), monellin (and variants thereof), sweet truffle protein (and variants thereof), sucralose, potassium acesulfame, aspartame, saccharin, cyclamate, and combinations thereof; and

iii. at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate,

wherein the beverage comprises the orange juice in an amount from about 10% to about 90% by weight, the at least one high potency sweetener in an amount from about 1 ppm to about 600 ppm, and the at least one salt in an amount from about 250 ppm to about 500 ppm.

18. A reduced calorie orange juice beverage comprising:

i. orange juice;

ii. at least one high potency sweetener comprising a steviol glycoside mixture comprising at least about 50% rebaudioside A by weight on a dry basis; and

iii. at least one salt selected from the group consisting of sodium gluconate, sodium citrate, sodium lactate, potassium gluconate, potassium citrate, and potassium lactate,

wherein the beverage comprises the orange juice in an amount from about 10% to about 90% by weight, the at least one high potency sweetener in an amount from about 25 to about 600 ppm, or from about 100 ppm to about 300 ppm, and the at least one salt in an amount from about 250 ppm to about 500 ppm.

19. The reduced calorie orange juice beverage of claim 18, wherein the steviol glycoside mixture comprises at least about 95% rebaudioside A by weight on a dry basis.

20. The reduced calorie orange juice beverage of claim 18, further comprising at least one of the following: water, pulp, natural flavor, organic acid, or a combination thereof.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2023/066582

A. CLASSIFICATION OF SUBJECT MATTER

A23L 2/06(2006.01)i; **A23L 2/60**(2006.01)i

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)

A23L 2/06(2006.01); A23G 4/00(2006.01); A23L 1/22(2006.01); A23L 27/10(2016.01); A24B 15/34(2006.01); A24B 3/12(2006.01); C12G 3/04(2006.01)

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

Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) & Keywords: reduced calorie, high potency sweetener, rebaudioside A, organic acid salt, orange juice

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007-0128311 A1 (PRAKASH, I. et al.) 07 June 2007 (2007-06-07) claim 1; paragraphs [0002]-[0959]	1-20
X	KR 10-2010-0094505 A (SAN EI GEN FFI INC.) 26 August 2010 (2010-08-26) claims 1, 4; paragraphs [0105]-[0107], [0113], [0133], [0198]-[0201], [0233]-[0240]; tables 9-10	1-20
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A	WO 2021-215394 A1 (SUNTORY HOLDINGS LIMITED) 28 October 2021 (2021-10-28) the whole document	1-20

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
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"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
23 August 2023	**23 August 2023**

Name and mailing address of the ISA/KR	Authorized officer
Korean Intellectual Property Office **189 Cheongsa-ro, Seo-gu, Daejeon** **35208, Republic of Korea**	**HEO, Joo Hyung**
Facsimile No. **+82-42-481-8578**	Telephone No. **+82-42-481-5373**

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/US2023/066582

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