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(54) **Title**: SUBSTANTIALLY CLEAR NUTRITIONAL LIQUIDS COMPRISING CALCIUM HMB AND SOLUBLE PROTEIN

(57) **Abstract**: Disclosed are substantially clear nutritional liquids comprising protein and calcium HMB wherein soluble protein represents from about 65% to 100% by weight of total protein. The liquids have a pH of from about 2.8 to about 4.6 and may be manufactured as a hot fill product. The substantially clear nutritional liquids may also have a weight ratio of calcium HMB to soluble calcium of from 4.5:1 to 7.3:1. In some embodiments, the substantially clear nutritional liquids are substantially free of fat, and may optionally include isomaltulose and/or beta alanine.

SUBSTANTIALLY CLEAR NUTRITIONAL LIQUIDS COMPRISING CALCIUM HMB AND SOLUBLE PROTEIN

FIELD OF THE DISCLOSURE

[0001] The present disclosure relates to substantially clear nutritional liquids comprising calcium beta-hydroxy-beta methylbutyrate (calcium HMB) and soluble protein. The present disclosure further relates to substantially clear nutritional liquids comprising calcium HMB and soluble protein and having a pH of from about 2.8 to about 4.6.

BACKGROUND OF THE DISCLOSURE

[0002] Nutritional supplements are widely commercially available and are generally intended to supplement other nutritional sources. Currently available nutritional supplements include both emulsified supplements (generally "milk-based" supplements) and non-emulsified supplements ("clear" supplements). Many individuals today prefer to utilize clear supplements as they can provide a thin, good-tasting and refreshing means of supplementing energy, protein, vitamins and minerals.

[0003] An important nutrient in nutritional formulations is calcium. Calcium is the most abundant mineral in the body. Calcium is required for muscle contraction, blood vessel expansion and contraction, secretion of hormones and enzymes, and transmitting impulses throughout the nervous system. It is also important for bones and teeth health, where it supports their structure.

[0004] Another important supplement for nutritional formulations is beta-hydroxy-beta-methylbutyrate (HMB). HMB is a naturally occurring amino acid metabolite that is often formulated into a variety of nutritional products and supplements. HMB is commonly used in such products to help build or maintain healthy muscle mass and strength in selected individuals.

[0005] HMB is a metabolite of the essential amino acid leucine and has been shown to modulate protein turnover and inhibit proteolysis. In most individuals,

muscle converts approximately 5% of available leucine to HMB, thus producing about 0.2 to 0.4 grams of HMB per day for a 70 kg male. In studies where various kinds of stress were induced in animals, HMB supplementation increased lean mass. Clinical studies also suggest that HMB has at least two functions in recovery from illness or injury including protection of lean mass from stress-related damage and enhancement of protein synthesis. It has been suggested that HMB may also be useful in enhancing immune function, reducing the incidence or severity of allergy or asthma, reducing total serum cholesterol and low density lipoprotein cholesterol, increasing the aerobic capacity of muscle, and other uses.

[0006] Since HMB is most often used in individuals to support the development and maintenance of healthy muscle mass and strength, many HMB products have been formulated with additional nutrients that may also be helpful in promoting healthy muscle. Some of these HMB products contain additional nutrients such as fat, carbohydrate, protein, vitamins, minerals and so forth. Calcium HMB is the most commonly used form of HMB when formulated into oral nutritional products, which products include tablets, capsules, reconstitutable powders, and nutritional liquids and emulsions.

[0007] It has been found, however, that substantially clear nutritional liquids containing protein, calcium HMB, along with supplemental calcium in some cases, are not physically stable over time as soluble calcium species present in the system can interact with intact proteins resulting in protein aggregation that results in sediment, gelation, and/or coagulation defects in the resulting product. This is especially true for acidified shelf stable liquid beverages subjected to high heat, such as that of a retort sterilization process, during manufacturing for microbiological control.

[0008] There is therefore a need for substantially clear nutritional liquids comprising calcium HMB, supplemental calcium, and proteins that remain physically stable during shelf life.

SUMMARY OF THE DISCLOSURE

[0009] In one embodiment, the present disclosure is directed to a substantially clear nutritional liquid comprising calcium HMB and protein and having a pH of from about 2.8 to 4.6. From about 65% to 100% by weight of total protein is soluble protein.

[0010] Another embodiment of the present disclosure is directed to a substantially clear nutritional liquid comprising calcium HMB and protein and having a pH of from about 2.8 to 4.6. From about 65% to 100% by weight of total protein is soluble protein and the weight ratio of calcium HMB to soluble calcium is from 4.5:1 to 7.3:1.

[0011] Another embodiment of the present disclosure is directed to a substantially clear nutritional liquid comprising calcium HMB, protein, isomaltulose, beta-alanine, and Vitamin D and having a pH of from about 2.8 to 4.6. From about 65% to 100% by weight of total protein is soluble protein and the weight ratio of calcium HMB to soluble calcium is from 4.5:1 to 7.3:1. The Vitamin D is present in an amount up to about 1000 IU.

[0012] It has been discovered that lower pH substantially clear nutritional liquids comprising calcium HMB in combination with protein can be physically unstable over time, often resulting in the collection of excessive protein-containing and/or other sediments at the bottom of the liquid, thus reducing nutrient availability as well as the effective shelf life of the product.

[0013] It has now also been found that a substantially clear nutritional liquid including HMB and protein can be provided by formulating the liquid to have a pH of from about 2.8 to 4.6 and including soluble protein in an amount of from about 65% to 100% by weight of the total protein. Surprisingly, even at very high levels of calcium in the product, the protein remains stable and the liquid substantially clear under these conditions. Stability may be further improved if the clear nutritional liquid has a weight ratio of calcium HMB to soluble calcium of from 4.5:1 to 7.3:1. Soluble proteins of particular use in this regard include whey protein isolate, whey

protein concentrate, casein hydrolysate, hydrolyzed collagen, and combinations thereof.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0014] The substantially clear nutritional liquids of the present disclosure comprise water, calcium HMB and soluble protein and optionally beta-alanine, carbohydrates, vitamins, and minerals. The essential features of the substantially clear liquids, as well as some of the many optional variations and additions, are described in detail hereafter.

[0015] The term "substantially clear nutritional liquid" as used herein, unless otherwise specified, refers to a non-emulsified or similar other liquid having a visibly clear or translucent appearance, which liquid may and typically will have a thin or watery texture with a consistency similar to that of a clear juice and most typically having a viscosity of less than about 25 centipoise as determined by a Brookfield viscometer at 22°C using a #1 spindle at 60 rpm.

[0016] The term "calcium HMB" as used herein, unless otherwise specified, refers to the calcium salt of beta-hydroxy-beta-methylbutyrate (also referred to as beta-dydroxyl-3-methyl butyric acid, beta-hydroxy isovaleric acid, or HMB), which is most typically in a monohydrate form. All weights, percentages, and concentrations as used herein to characterize calcium HMB are based on the weight of calcium HMB monohydrate, unless otherwise specified.

[0017] The terms "fat" and "oil" as used herein, unless otherwise specified, are used interchangeably to refer to lipid materials derived or processed from plants or animals. These terms also include synthetic lipid materials so long as such synthetic materials are suitable for oral administration to humans.

[0018] The term "shelf stable" as used herein, unless otherwise specified, refers to a substantially clear nutritional liquid that remains commercially stable after being packaged and then stored at 18-24°C for at least 3 months, including from about

6 months to about 24 months, and also including from about 12 months to about 18 months.

[0019] The term "plastic" as used herein, unless otherwise specified, means food grade plastics approved by the U.S. Food and Drug Administration or other suitable regulatory group, some non-limiting examples of which include polyvinyl chlorides, polyethylene terephthalate, high density polyethylene, polypropylenes, polycarbonates, and so forth.

[0020] The terms "sterile", "sterilized" and "sterilization" as used herein, unless otherwise specified, refer to the reduction in transmissible agents such as fungi, bacteria, viruses, spore forms, and so forth, in food or on food grade surfaces to the extent necessary to render such foods suitable for human consumption. Sterilization processes may include various techniques involving the application of heat, peroxide or other chemicals, irradiation, high pressure, filtration, or combinations or variations thereof.

[0021] All percentages, parts and ratios as used herein, are by weight of the total composition, unless otherwise specified. All such weights as they pertain to listed ingredients are based on the active level and, therefore, do not include solvents or by-products that may be included in commercially available materials, unless otherwise specified.

[0022] All references to singular characteristics or limitations of the present disclosure shall include the corresponding plural characteristic or limitation, and vice versa, unless otherwise specified or clearly implied to the contrary by the context in which the reference is made.

[0023] All combinations of method or process steps as used herein can be performed in any order, unless otherwise specified or clearly implied to the contrary by the context in which the referenced combination is made.

[0024] The various embodiments of the substantially clear nutritional liquids of the present disclosure may also be substantially free of any optional or selected

essential ingredient or feature described herein, provided that the remaining substantially clear nutritional liquid still contains all of the required ingredients or features as described herein. In this context, and unless otherwise specified, the term "substantially free" means that the selected substantially clear nutritional liquid contains less than a functional amount of the optional ingredient, typically less than about 1%, including less than about 0.5%, including less than about 0.1%, and also including zero percent, by weight of such optional or selected essential ingredient.

[0025] The substantially clear nutritional liquids and corresponding manufacturing methods of the present disclosure can comprise, consist of, or consist essentially of the essential elements of the disclosure as described herein, as well as any additional or optional element described herein or otherwise useful in substantially clear nutritional liquid applications.

Product Form

[0026] The substantially clear nutritional liquids of the present disclosure are thin liquids comprising at least protein, carbohydrate and calcium HMB as discussed below. The substantially clear nutritional liquids are substantially fat free; that is, the liquids are devoid of added fat except for that fat inherent to the raw materials or added fat at low concentrations to aid in the manufacture the liquid. In this context, the term "fat free" means that the liquid typically contains less than 1.0 %, more typically less than 0.5%, and more typically less than 0.1%, including zero percent, fat by weight of the nutritional liquid. These substantially clear nutritional liquids are flowable or drinkable liquids at from about 1 to about 25°C.

[0027] The substantially clear nutritional liquids may be and typically are shelf-stable. The liquids typically contain up to about 95% by weight of water, including from about 50% to about 95%, also including from about 60% to about 90%, and also including from about 70% to about 85%, of water by weight of the substantially clear nutritional liquid.

[0028] The substantially clear nutritional liquids may be formulated with sufficient kinds and amounts of nutrients so as to provide a supplemental source of

nutrition, or to provide a specialized nutritional liquid for use in individuals afflicted with specific diseases or conditions. These substantially clear nutritional liquids may thus have a variety of product densities, but most typically have a density greater than about 1.040 g/ml, including from 1.06 g/ml to 1.12 g/ml, and also including from about 1.085 g/ml to about 1.10 g/ml.

[0029] The substantially clear nutritional liquids may have a caloric density tailored to the nutritional needs of the ultimate user, although in most instances the liquids comprise from about 90 to about 500 kcal/240 ml, including from about 150 to about 350 kcal/240 ml, including from about 180 to about 350 kcal/240 ml and also including from about 250 to about 320 kcal/240 ml. In other embodiments, the substantially clear nutritional liquids comprise from about 90 to about 500 kcal/480 ml, including from about 150 to about 350 kcal/480 ml, and also including from about 250 to about 320 kcal/480 ml. These substantially clear nutritional liquids also comprise calcium HMB as described hereinafter, the amount of which most typically ranges from about 0.4 to about 3.0 gm/240 ml, including from about 0.75 to about 2.0 gm/240 ml, including about 1.5 gm/240 ml.

[0030] The substantially clear nutritional liquids have a pH ranging from about 2.8 to about 4.6, including from about 2.9 to about 4.2, and also including from about 3.1 to about 3.9. Within these pH ranges, the calcium HMB remains associated and as such, the interaction between the calcium and the protein in the formulation is minimized or avoided. This then minimizes or avoids the formation of sediment, gelation, and coagulation. Within this selected pH range, the undesirable sediment, gelation and coagulation is minimized or prevented even at temperatures greater than 180°F, which is the preferred minimum temperature for a suitable process for acidified products, as described below.

[0031] Although the serving size for the substantially clear nutritional liquid can vary depending upon a number of variables, a typical serving size ranges from about 100 to about 591 ml, including from about 150 to about 250ml, including from about 190 ml to about 240 ml. Some specific serving sizes for the substantially clear

nutritional liquid include 240 ml (8.1 ounce), 296 ml (10 ounce) and 480 ml (16 ounce).

Calcium HMB

[0032] The substantially clear nutritional liquids comprise HMB, and preferably calcium HMB, which means that the liquids are either formulated with the addition of calcium HMB, most typically as a monohydrate, or are otherwise prepared so as to contain calcium and HMB in the finished product. Any source of HMB is suitable for use herein provided that the finished product contains calcium and HMB, although such a source is preferably calcium HMB and is most typically added as such to the substantially clear nutritional liquids during formulation.

[0033] The term "added calcium HMB" as used herein means a calcium salt of HMB, most typically as monohydrate calcium salt of HMB, as the HMB source added to the substantially clear nutritional liquid.

[0034] Although calcium HMB monohydrate is the preferred source of HMB for use herein, other suitable sources may include HMB as the free acid, a salt, an anhydrous salt, an ester, a lactone, or other product forms that otherwise provide a bioavailable form of HMB from the substantially clear nutritional liquid. Non-limiting examples of suitable salts of HMB for use herein include HMB salts, hydrated or anhydrous, of sodium, potassium, magnesium, chromium, calcium, or other non-toxic salt form. Calcium HMB monohydrate is preferred and is commercially available from Technical Sourcing International (TSI) of Salt Lake City, Utah.

[0035] The concentration of calcium HMB in the substantially clear nutritional liquids may range up to about 10%, including from about 0.01% to about 8%, and also including from about 0.08% to about 5.0%, and also including from about 0.08% to about 3%, and also including from about 0.1% to about 2.5%, by weight of the substantially clear nutritional liquid. In some embodiments, the substantially clear nutritional liquids are formulated such that the liquid provides from

about 0.5 grams to about 3.0 grams, including 1.5 grams of calcium HMB per 8.1 fluid ounces (240 ml).

Soluble Protein

[0036] The substantially clear nutritional liquids of the present disclosure may comprise selected amounts or ratios of soluble protein as defined herein to improve product performance and stability during shelf life.

[0037] The soluble protein may represent from about 65% to 100%, including from 80% to 100%, including from about 85% to about 100%, including from about 90% to about 100%, including from about 95% to about 100%, and also including about 100%, by weight of the total protein in the substantially clear nutritional liquid. The concentration of soluble protein may range from at least about 0.5%, including from about 1% to about 30%, and also including from about 2% to about 15%, also including from about 3% to about 10%, and also including from about 3% to about 5%, by weight of the substantially clear nutritional liquid. In some embodiments, the substantially clear nutritional liquid provides at least about 5 grams, or even 6 grams, or even 7 grams, or even 8 grams, or even 9 grams, or even 10 grams of total protein per 8 fluid ounce serving.

[0038] The amount of soluble protein included in the substantially clear nutritional liquids may also be characterized as a weight ratio of soluble protein to calcium HMB, wherein substantially clear nutritional liquid includes a weight ratio of soluble protein to calcium HMB of at least about 3.0, including from about 4.0 to about 12.0, also including 6.1 to about 12, also including from about 7.0 to about 11.0, and also including from about 8.0 to about 10.0.

[0039] The term "soluble protein" as used herein, unless otherwise specified, refers to those proteins having a protein solubility of at least about 40%, including from 50% to 100%, and also including from 60% to 90%, as measured in accordance with the following process: (1) suspend protein ingredient in purified water at 5.00 g per 100 g of suspension; (2) adjust the pH of the suspension to 3.5 or the desired product pH (e.g., 4.6 or other) using HCl, Phosphoric Acid, Citric Acid or

combinations thereof; (3) stir vigorously at room temperature (20°C-22°C) for 60 minutes; (4) measure total protein in the suspension by any suitable technique (including the HPLC technique described below); (5) centrifuge an aliquot of the suspension at 31,000 x g and at 20°C for 1 hour; (6) measure the supernatant for protein by the selected technique as described in step (4); and (7) calculate protein solubility as the supernatant protein percentage of the total protein.

[0040] Protein concentration (per step 4 above) can be measured in the protein solubility process by any known or otherwise suitable method for determining such concentrations, many of which are well known in the analytical art. An example of one such suitable method is by HPLC analysis in accordance with the following specifications: (1) Column: Shodex KW-804 protein size exclusion chromatography column, Waters P/N WAT036613; (2) Mobile Phase: 0.05M NaH_2PO_4, 0.15M NaCl, pH = 7.0; (3) Flow Rate: 0.3 mL/minute; (4) Temperature: 22°C; (5) Detection: UV at 214 nm; (6) Injection: 10 µL; (7) Run Time: 90 minutes; (8) System Calibration: protein standard solutions prepared at 0.5 – 3.0 g/L in mobile phase; and (9) Sample Preparation: dilute to about 1.5 g/L protein with mobile phase.

[0041] Any soluble protein source is suitable for use herein provided that it meets the solubility requirement as defined herein, some non-limiting examples of which include whey protein concentrate (>90% solubility), whey protein isolate (>90% solubility), casein hydrolysate (>60% solubility), hydrolyzed collagen, combinations thereof. Non-soluble proteins may of course also be included in the substantially clear nutritional liquids described herein provided that the remaining soluble protein component is represented in accordance with the requirements as set forth herein. The composition may be substantially free of proteins other than the soluble protein as described herein.

[0042] Soluble protein suitable for use herein may also be characterized by the content of phosphoserine in the protein, wherein the soluble proteins in this context are defined as those proteins having at least about 100 mmoles, including from about 150 to 400 mmoles, including from about 200 to about 350 mmoles, and

also including from about 250 to about 350 mmoles, of phosphoserine per kilogram of protein.

[0043] When the soluble protein is defined in terms of phosphoserine content, it has been found that the weight ratio of the soluble protein (with the defined phosphoserine content) to the calcium HMB may be at least about 3:1, including at least about 5:1, and also including at least about 7:1, and also including from about 9:1 to about 30:1. In this context, the proteins having the requisite content of phosphoserine are most typically in the form of monovalent caseinate salts such as sodium caseinate, potassium caseinate, and combinations thereof.

[0044] In one embodiment, the soluble protein may also be characterized by a mole ratio of monovalent caseinate phosphoserine to calcium HMB monohydrate of least about 0.2, including from about 0.2 to about 2.0, and also including from about 0.25 to 1.7.

[0045] It should be understood, however, that any phosphoserine-containing protein may be suitable for use herein provided that it has the requisite phosphoserine content and that the phosphoserine used in calculating the ratios are not bound, complexed, or otherwise attached to a polyvalent cation such as calcium or magnesium.

[0046] It should also be noted that alternative definitions as described herein for soluble proteins may include proteins that have little or no phosphoserine content, so that the soluble protein fraction of the compositions may include soluble protein with and/or without phosphoserine. The soluble protein for use herein may therefore be defined by any one or more of the soluble protein characterizations, separately or in combination.

[0047] The phosphoserine moieties within the protein may therefore be available for binding with the calcium released from the calcium HMB so that the above ratios of soluble protein to calcium HMB are the ratio of protein with phosphoserine moities that are unbound, unattached, or otherwise available to bind soluble calcium from the calcium HMB during formulation. It could be, for example,

that a mixture of calcium caseinate and sodium caseinate are used in the composition, but the ratio of proteins defined by a phosphoserine content to calcium HMB is calculated based on the protein fraction from the sodium caseinate and additionally any protein from the calcium caseinate fraction that is not bound to calcium.

[0048] It should be noted, however, that any protein selected for use herein as a soluble protein must also meet the solubility testing requirements noted above even if the protein is whey protein concentrate, casein hydrolysate, or other typically soluble protein since protein solubility can vary significantly with the selection of raw material lots, sources, brands, and so forth.

Soluble Calcium

[0049] As noted above, it is generally desirable to minimize the amount of soluble calcium present in the substantially clear nutritional liquid to minimize the amount of interaction with the proteins and minimize the amount of sediment formed.

[0050] The substantially clear nutritional liquids of the present disclosure, however, comprise calcium as a desirable ingredient in the liquids suitable for use in developing or maintaining healthy muscle in targeted individuals, as well as for other benefits. Some or all of the calcium may be provided by the addition of calcium HMB as described herein. Any other calcium source, however, may be used provided that such other source is compatible with the essential elements of the substantially clear nutritional liquids.

[0051] The concentration of calcium in the substantially clear nutritional liquids typically exceeds about 10 mg/L, and may also include concentrations of from about 25 mg/L to about 3000 mg/L, also including from about 50 mg/L to about 500 mg/L, and also including from about 100 mg/L to about 300mg/L.

[0052] To minimize the stability issues in the substantially clear nutritional liquids, the calcium is generally formulated so as to minimize the extent to which the calcium is solubilized in the liquids. As such, solubilized calcium concentrations in the liquids may be less than about 1500 mg/L, including less than about 1250 mg/L,

also including from about 500 mg/L to about 1250 mg/L, and also including from about 200 mg/L to about 600 mg/L. In this context, the term "solubilized calcium" refers to free, ionized, or supernatant calcium in the liquid as measured at 20°C.

[0053] The calcium component of the substantially clear nutritional liquid may also be characterized by a solubilized calcium level that represents less than 900 mg/L, including less than 700 mg/L, and also including less than 600 mg/L, and also including from 400 mg/L to 700 mg/L of the liquid, wherein the weight ratio of calcium HMB to the solubilized calcium ranges from about 4.5 to about 7.3, including from about 4.5 to about 6, also including from about 5 to about 6.

Protein

[0054] In addition to the soluble protein as described above, in some embodiments of the present disclosure the substantially clear nutritional liquids may comprise one or more additional proteins such that the liquid includes both soluble and insoluble proteins. The total concentration of protein in the liquid (including all soluble and insoluble protein) may range from at least about 0.5%, including from about 1% to about 30%, and also including from about 2% to about 15%, also including from about 3% to about 10%, and also including from about 3% to about 5%, by weight of the substantially clear nutritional liquid.

[0055] Non-limiting examples of additional suitable protein or sources thereof for use in the substantially clear nutritional liquids include hydrolyzed or partially hydrolyzed proteins or protein sources, which may be derived from any known or otherwise suitable source such as milk (e.g., casein, whey), animal (e.g., meat, fish), cereal (e.g., rice, corn), vegetable (e.g., soy) or combinations thereof. Non-limiting examples of such proteins include milk protein isolates, milk protein concentrates as described herein, casein protein isolates, whey protein, whole cow's milk, partially or completely defatted milk, soy protein isolates, soy protein concentrates, combinations thereof, and so forth.

Carbohydrate

[0056] In addition to calcium HMB and protein, the substantially clear nutritional liquids of the present disclosure may include carbohydrates. Generally, the carbohydrate component of the substantially clear nutritional liquid is present in an amount of at least about 5%, including from about 10% to about 50%, including from about 10% to about 40%, including from about 10% to about 30%, including from about 20% to about 30% by weight of the substantially clear nutritional liquid.

[0057] Non-limiting examples of suitable carbohydrates or sources thereof for use in the substantially clear nutritional liquids described herein may include maltodextrin, hydrolyzed or modified starch or cornstarch, glucose polymers, corn syrup, corn syrup solids, rice-derived carbohydrates, sucrose, glucose, fructose, lactose, high fructose corn syrup, honey, sugar alcohols (e.g., maltitol, erythritol, sorbitol), artificial sweeteners (e.g., sucralose, acesulfame potassium, stevia) and combinations thereof.

Beta Alanine

[0058] The substantially clear nutritional liquids of the present disclosure may further comprise in some embodiments the amino acid beta alanine, which means that the substantially clear nutritional liquids are either formulated with the addition of beta alanine, or are otherwise prepared so as to contain beta alanine in the finished product.

[0059] Any source of beta alanine is suitable for use in the products described herein provided that the finished product contains beta alanine at the desired level. Such sources may and typically do include free beta alanine as well as other sources that provide free beta alanine in the nutritional liquid during or after formulation. However, although the present liquids may further comprise proteins or hydrolyzed proteins containing peptides having beta alanine moieties, the beta alanine from such peptide-bound moieties, if any, are not considered part of the beta alanine feature when defining the present disclosure. One suitable source of beta alanine is commercially available from Compounds Solutions (Escondido, California).

[0060] The concentration of beta alanine in the substantially clear nutritional liquids may range from about 0.1% to about 3.0%, or even from about 0.1% to about 2.0%, or even from about 0.1% to about 1.0% or even from about 0.1% to about 0.33% by weight of the substantially clear nutritional liquid.

Isomaltulose

[0061] The substantially clear nutritional liquids of the present disclosure may further comprise isomaltulose, or other slow digesting carbohydrates such as sucromalt. Any source of isomaltulose is suitable for use herein provided it is suitable for use in a nutritional product and is otherwise compatible with the essential and optionally selected ingredients in the formulation.

[0062] The concentration of isomaltulose in the nutritional liquids may range from about 0.01% to about 10%, including from about 0.1% to about 7%, including from about 0.1% to about 2%, by weight of the nutritional liquid.

Vitamin D

[0063] The substantially clear nutritional liquids of the present disclosure may further comprise in some embodiments Vitamin D to help maintain and build healthy muscle in the targeted user. Suitable Vitamin D forms include Vitamin D2 (ergocalciferol) and Vitamin D3 (cholecalciferol), or other forms suitable for use in a liquid nutritional product. The amount of Vitamin D in the substantially clear nutritional liquid most typically ranges up to about 3000IU, more typically up to about 2000IU, more typically up to about 1000 IU, more typically from about 10 to about 600 IU, and more typically from about 50 to 400 IU, per serving of the substantially clear nutritional liquid.

Optional Ingredients

[0064] The substantially clear nutritional liquids described herein may further comprise other optional ingredients that may modify the physical, chemical, hedonic or processing characteristics of the products or serve as pharmaceutical or additional nutritional components when used in the targeted population. Many such

optional ingredients are known or otherwise suitable for use in other nutritional products and may also be used in the clear nutritional liquids described herein, provided that such optional ingredients are safe and effective for oral administration and are compatible with the essential and other ingredients in the selected product form.

[0065] Non-limiting examples of such optional ingredients include preservatives, antioxidants, emulsifying agents, buffers, pharmaceutical actives, additional nutrients as described herein, colorants, flavors, thickening agents and stabilizers, and so forth.

[0066] The liquids may further comprise vitamins or related nutrients, non-limiting examples of which include vitamin A, vitamin E, vitamin K, thiamine, riboflavin, pyridoxine, vitamin B12, carotenoids, niacin, folic acid, pantothenic acid, biotin, vitamin C, choline, inositol, salts, and derivatives thereof, and combinations thereof.

[0067] The liquids may further comprise minerals, non-limiting examples of which include phosphorus, magnesium, iron, zinc, manganese, copper, sodium, potassium, molybdenum, chromium, selenium, chloride, and combinations thereof.

[0068] The liquids may also include one or more flavoring or masking agents. Suitable flavoring or masking agents include natural and artificial sweeteners, sodium sources such as sodium chloride, and hydrocolloids, such as guar gum, xanthan gum, carrageenan, gellan gum, gum acacia and combinations thereof.

Methods of Manufacture

[0069] The substantially clear nutritional liquids described herein may be manufactured by any known or otherwise suitable method for making acidic beverages, including acidic, shelf-stable beverages, including retort, aseptic filling, and hot fill process. In one suitable embodiment, a hot fill process as described below is utilized.

[0070] In one suitable embodiment, the protein component is first dissolved in water with a temperature ranging from room temperature (approx. 70°F) up to 135°F, for example. Once the protein is dissolved and a slurry formed, the resulting slurry is adjusted into a pH range of from about 2.8 to about 4.2 using an appropriate acid system, such as for example phosphoric acid and citric acid.

[0071] A second slurry is prepared by dissolving the carbohydrate component, the calcium HMB, and optionally the beta alanine, in water at an elevated temperature such as 175°F, for example. Once the carbohydrate component is dissolved, the protein slurry and the carbohydrate slurry are homogenized and vitamins, minerals and/or other ingredients are added into the resulting slurry. Once a final homogenized slurry is prepared, the resulting slurry is heated to a temperature of at least about 180°F, desirably at least about 200°C, and held at that temperature for at least about 20 seconds to kill mold, bacteria, and yeast. Prior to filling a suitable plastic or other container with the hot liquid, the liquid may optionally be rapidly cooled to 140°F to 150°F. By filling the hot liquid into the container, the container itself is also sterilized. Generally, during or after the filling of the hot liquid, the container is rotated so that the headspace area is also sterilized.

Methods of Use

[0072] The substantially clear nutritional liquids of the present disclosure may be utilized by any person who could benefit from the use of a substantially clear nutritional liquid including calcium HMB. The substantially clear nutritional liquid may be particularly suitable for individuals suffering from malnutrition and/or muscle wasting or suffering from conditions such as fat restrictive diets, cancer, disease related malnutrition, short bowel syndrome, inflammatory bowel syndrome, cachexia, as well as other conditions or diseases. The nutritional liquids are also suitable for use in healthy individuals, including athletes and other physically active individuals in whom the benefits of the beta alanine and calcium HMB for muscle health can be realized.

EXAMPLES

[0073] The following examples illustrate specific embodiments and or features of the substantially clear nutritional liquids of the present disclosure. The examples are given solely for the purpose of illustration and are not to be construed as limitations of the present disclosure, as many variations thereof are possible without departing from the spirit and scope of the disclosure. All exemplified amounts are weight percentages based upon the total weight of the composition, unless otherwise specified.

[0074] The exemplified compositions are shelf stable substantially clear nutritional liquids prepared in accordance with the manufacturing methods described herein, such that each exemplified composition is a hot filled product and then repeated again in new batches as an aseptically processed product. These compositions are substantially clear nutritional liquids that are packaged in 240 ml plastic containers and remain physically stable for 12-18 months after formulation/packaging at storage temperatures ranging from 1-25°C. Each formulation has a pH value of from 2.8 to 4.6.

Examples 1-4

[0075] Examples 1-4 illustrate substantially clear nutritional liquids including HMB and soluble protein of the present disclosure, the ingredients of which are listed in the table below. All ingredient amounts are listed as kilogram per 1000 kilogram batch of product, unless otherwise specified.

Ingredient	Example 1	Example 2	Example 3	Example 4
Water	Q.S.	Q.S.	Q.S.	Q.S.
Sucrose	109.0	109.0	0	54.5
Isomaltulose	0	0	109.0	54.5
Whey Protein Isolate	42.90	32.18	42.90	41.90
Hydrolyzed Casein	0	10.72	0	0
Phosphoric Acid	2.0	2.0	2.0	2.0
Citric Acid	1.4	1.4	1.4	1.4
Calcium HMB	5.69	5.69	5.69	5.69
Flavor	700 g	700 g	700 g	700 g
Ascorbic Acid	535 g	535 g	535 g	535 g

Color	400 g	400 g	400 g	400 g
UTM/TM Premix	230 g	230 g	230 g	230 g
Zinc Sulfate monohydrate*	52.1 g	52.1 g	52.1 g	52.1 g
Ferrous Sulfate*	40.8 g	40.8 g	40.8 g	40.8 g
Citric Acid*	14.2 g	14.2 g	14.2 g	14.2 g
Manganese sulfate*	13.0	13.0	13.0	13.0
Copper Sulfate*	7.1 g	7.1 g	7.1 g	7.1 g
Chromium Chloride*	430 mg	430 mg	430 mg	430 mg
Sodium Molybdate*	339 mg	339 mg	339 mg	339 mg
Sodium Selenate*	146 mg	146 mg	146 mg	146 mg
Water Dispersible ADEK Premix	178 g	178 g	178 g	178 g
di-Alpha-Tocopheryl Acetate**	45.3 g	45.3 g	45.3 g	45.3 g
Vitamin A Palmitate**	4.2 g	4.2 g	4.2 g	4.2 g
Phylloquinone**	127 mg	127 mg	127 mg	127 mg
Vitamin D3**	23 mg	23 mg	23 mg	23 mg
Vitamin Premix	37.9 g	37.9 g	37.9 g	37.9 g
Niacinamide***	14.2 g	14.2 g	14.2 g	14.2 g
d-Calcium pantothenate***	9.2 g	9.2 g	9.2 g	9.2 g
Thiamine chloride hydrochloride***	2.4 g	2.4 g	2.4 g	2.4 g
Pyridoxine hydrochloride***	2.3 g	2.3 g	2.3 g	2.3 g
Riboflavin***	1.8 g	1.8 g	1.8 g	1.8 g
Folic Acid***	350 mg	350 mg	350 mg	350 mg
Biotin***	277 mg	277 mg	277 mg	277 mg
Cyanocobalamin***	6.3 mg	6.3 mg	6.3 mg	6.3 mg
Folic Acid	1.3 g	1.3 g	1.3 g	1.3 g
Potassium Iodide	204 mg	204 mg	204 mg	204 mg
Beta-Alanine	0	0	0	1.0
Features				
Soluble protein/total protein (wt/wt)	100%	75%	100%	100%

*UTM/TM Premix; **ADEK Premix; ***WSV Vitamin Premix

Examples 5-8

[0076] Examples 5-8 illustrate substantially clear nutritional liquids of the present disclosure, the ingredients of which are listed in the table below. All ingredient amounts are listed as kg per 1000 kg batch of product, unless otherwise specified.

Ingredient	Example 5	Example 6	Example7	Example 8
Water	Q.S.	Q.S.	Q.S.	Q.S.
Sucrose	190.0	190.0	0	90
Isomaltulose	0	0	190.0	90
Whey Protein Concentrate (70%)	49.5	32.17	32.17	48.5
Hydrolyzed Casein	0	12.38	12.38	0

Phosphoric Acid (85%)	2.33	2.33	2.33	2.33
Citric Acid	1.98	1.98	1.98	1.98
Calcium HMB	5.69	5.69	5.69	5.69
Flavor	700 g	700 g	700 g	700 g
Ascorbic Acid	535 g	535 g	535 g	535 g
Color	400 g	400 g	400 g	400 g
UTM/TM Premix	230 g	230 g	230 g	230 g
Zinc Sulfate monohydrate*	52.1 g	52.1 g	52.1 g	52.1 g
Ferrous Sulfate*	40.8 g	40.8 g	40.8 g	40.8 g
Citric Acid*	14.2 g	14.2 g	14.2 g	14.2 g
Manganese sulfate*	13.0	13.0	13.0	13.0
Copper Sulfate*	7.1 g	7.1 g	7.1 g	7.1 g
Chromium Chloride*	430 mg	430 mg	430 mg	430 mg
Sodium Molybdate*	339 mg	339 mg	339 mg	339 mg
Sodium Selenate*	146 mg	146 mg	146 mg	146 mg
Water Dispersible ADEK Premix	178 g	178 g	178 g	178 g
di-Alpha-Tocopheryl Acetate**	45.3 g	45.3 g	45.3 g	45.3 g
Vitamin A Palmitate**	4.2 g	4.2 g	4.2 g	4.2 g
Phylloquinone**	127 mg	127 mg	127 mg	127 mg
Vitamin D3**	23 mg	23 mg	23 mg	23 mg
Vitamin Premix	37.9 g	37.9 g	37.9 g	37.9 g
Niacinamide***	14.2 g	14.2 g	14.2 g	14.2 g
d-Calcium pantothenate***	9.2 g	9.2 g	9.2 g	9.2 g
Thiamine chloride hydrochloride***	2.4 g	2.4 g	2.4 g	2.4 g
Pyridoxine hydrochloride***	2.3 g	2.3 g	2.3 g	2.3 g
Riboflavin***	1.8 g	1.8 g	1.8 g	1.8 g
Folic Acid***	350 mg	350 mg	350 mg	350 mg
Biotin***	277 mg	277 mg	277 mg	277 mg
Cyanocobalamin***	6.3 mg	6.3 mg	6.3 mg	6.3 mg
Folic Acid	1.3 g	1.3 g	1.3 g	1.3 g
Potassium Iodide	204 mg	204 mg	204 mg	204 mg
Beta-Alanine	0	0	0	5.0
Features				
Soluble protein/total protein (wt/wt)	100%	75%	75%	100%

*UTM/TM Premix; **ADEK Premix; ***WSV Vitamin Premix

Example 9-12

[0077] Examples 9-12 illustrate substantially clear nutritional liquids including HMB and soluble protein of the present disclosure, the ingredients of which are listed in the table below. All ingredient amounts are listed as kilogram per 1000 kilogram batch of product, unless otherwise specified.

Ingredient	Example 9	Example 10	Example 11	Example 12
Water	Q.S.	Q.S.	Q.S.	Q.S.
Sucrose	196.0	196.0	0	98
Isomaltulose	0	0	190	98
Hydrolyzed Collagen	42.90	32.18	42.90	40.90
Hydrolyzed Casein	0	10.72	0	0
Phosphoric Acid	2.33	2.33	2.33	2.33
Citric Acid	1.98	1.98	1.98	1.98
Calcium HMB	5.69	5.69	5.69	5.69
Flavor	700 g	700 g	700 g	700 g
Ascorbic Acid	535 g	535 g	535 g	535 g
Color	400 g	400 g	400 g	400 g
UTM/TM Premix	230 g	230 g	230 g	230 g
Zinc Sulfate monohydrate*	52.1 g	52.1 g	52.1 g	52.1 g
Ferrous Sulfate*	40.8 g	40.8 g	40.8 g	40.8 g
Citric Acid*	14.2 g	14.2 g	14.2 g	14.2 g
Manganese sulfate*	13.0	13.0	13.0	13.0
Copper Sulfate*	7.1 g	7.1 g	7.1 g	7.1 g
Chromium Chloride*	430 mg	430 mg	430 mg	430 mg
Sodium Molybdate*	339 mg	339 mg	339 mg	339 mg
Sodium Selenate*	146 mg	146 mg	146 mg	146 mg
Water Dispersible ADEK Premix	178 g	178 g	178 g	178 g
di-Alpha-Tocopheryl Acetate**	45.3 g	45.3 g	45.3 g	45.3 g
Vitamin A Palmitate**	4.2 g	4.2 g	4.2 g	4.2 g
Phylloquinone**	127 mg	127 mg	127 mg	127 mg
Vitamin D3**	23 mg	23 mg	23 mg	23 mg
Vitamin Premix	37.9 g	37.9 g	37.9 g	37.9 g
Niacinamide***	14.2 g	14.2 g	14.2 g	14.2 g
d-Calcium pantothenate***	9.2 g	9.2 g	9.2 g	9.2 g
Thiamine chloride hydrochloride***	2.4 g	2.4 g	2.4 g	2.4 g
Pyridoxine hydrochloride***	2.3 g	2.3 g	2.3 g	2.3 g
Riboflavin***	1.8 g	1.8 g	1.8 g	1.8 g
Folic Acid***	350 mg	350 mg	350 mg	350 mg
Biotin***	277 mg	277 mg	277 mg	277 mg
Cyanocobalamin***	6.3 mg	6.3 mg	6.3 mg	6.3 mg
Folic Acid	1.3 g	1.3 g	1.3 g	1.3 g
Potassium Iodide	204 mg	204 mg	204 mg	204 mg
Beta-Alanine	0	0	0	2.0
Features				
Soluble protein/total protein (wt/wt)	100%	75%	100%	100%

*UTM/TM Premix; **ADEK Premix; ***WSV Vitamin Premix

WHAT IS CLAIMED IS:

1. A substantially clear nutritional liquid comprising calcium HMB and protein and having a pH of from about 2.8 to 4.6, wherein from about 65% to 100% by weight of total protein is soluble protein.

2. The substantially clear nutritional liquid of claim 1 wherein the soluble protein represents from about 85% to 100% by weight total protein and wherein the soluble protein includes phosphoserine-containing protein having at least about 100 mmoles of phosphoserine per kilogram of phosphoserine-containing protein.

3. The substantially clear nutritional liquid of claim 1 wherein the soluble protein includes at least one protein selected from the group consisting of whey protein concentrate, whey protein isolate, casein hydrolysate, hydrolyzed collagen, combinations thereof.

4. The substantially clear nutritional liquid of claim 1 wherein the calcium HMB is from about 0.1% to about 5.0% by weight of the substantially clear nutritional liquid.

5. The substantially clear nutritional liquid of claim 1 wherein the substantially clear liquid nutritional supplement comprises less than 1.0% by weight of fat.

6. The substantially clear nutritional liquid of claim 1 further comprising from about 0.1% to about 3.0% by weight of beta alanine.

7. The substantially clear nutritional liquid of claim 1 wherein the liquid has a pH of from 3.1 to 3.9.

8. The substantially clear nutritional liquid of claim 1 further including Vitamin D.

9. A substantially clear nutritional liquid comprising calcium HMB and protein and having a pH of from about 2.8 to 4.6, wherein from about 65% to 100% by

weight of total protein is soluble protein and wherein the weight ratio of calcium HMB to soluble calcium is from 4.5:1 to 7.3:1.

10. The substantially clear nutritional liquid of claim 9 wherein the soluble protein represents from about 85% to 100% by weight total protein and wherein the soluble protein includes phosphoserine-containing protein having at least about 100 mmoles of phosphoserine per kilogram of phosphoserine-containing protein.

11. The substantially clear nutritional liquid of claim 9 wherein the soluble protein includes at least one protein selected from the group consisting of whey protein concentrate, whey protein isolate, casein hydrolysate, hydrolyzed collagen, and combinations thereof.

12. The substantially clear nutritional liquid of claim 9 wherein the soluble protein is from about 1% to about 20% by weight of the substantially clear nutritional liquid.

13. The substantially clear nutritional liquid of claim 9 wherein the calcium HMB is from about 0.1% to about 2.5% by weight of substantially clear nutritional liquid.

14. The substantially clear nutritional liquid of claim 9 further comprising from about 0.1% to about 3.0% by weight of beta alanine.

15. A substantially clear nutritional liquid comprising calcium HMB, protein, isomaltulose, beta-alanine and Vitamin D and having a pH of from about 2.8 to 4.6, wherein from about 65% to 100% by weight of total protein is soluble protein, wherein the weight ratio of calcium HMB to soluble calcium is from 4.5:1 to 7.3:1, and wherein the Vitamin D is present in an amount of up to about 1000 IU.

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2011/039170

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23L1/30 A23L1/305 A23L2/52 A23L2/66
ADD.

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

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

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, FSTA, CHEM ABS Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2005/215640 A1 (BAXTER JEFFREY H [US] ET AL) 29 September 2005 (2005-09-29) paragraph [0073] - paragraph [0096]; claims 1-21; examples 5-10	1-15
A	WO 2007/075605 A2 (ABBOTT LAB [US]; THOMAS DEBRA L [US]; MUKERJI PRADIP [US]) 5 July 2007 (2007-07-05) paragraph [0051] - paragraph [0058] paragraph [0073]; tables 1-5	1-15
E	WO 2011/074995 A1 (OLIMP LAB SP Z O O [PL]; JEDLLNSKI MARCIN [PL]; JEDLLNSKI RAFAL [PL];) 23 June 2011 (2011-06-23) claims 1,7,17,191; example XXI; table 7	1,3-5,8, 9,11-13

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

☒ See patent family annex.

* Special categories of cited documents :

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 July 2011	03/08/2011

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
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