Title: IN-POD PRE-TREATMENT PHASE TO IMPROVE PREPARATION OF NUTRITIONAL LIQUIDS

Abstract: In an exemplary method for reconstituting a nutritional powder into a nutritional liquid, a container is provided with a hermetically enclosed chamber retaining a predetermined amount of the nutritional powder. At least one inlet aperture (32) is produced in the container, the at least one inlet aperture being in fluid communication with the chamber. A first volume of pre-treating fluid is introduced through the at least one inlet aperture into the chamber to pre-treat the nutritional powder. An outlet aperture (34) is produced in the container, the outlet aperture being in fluid communication with the chamber. A second volume of reconstituting fluid is introduced through the at least one outlet aperture into the chamber, and the pre-treating fluid, the reconstituting fluid, and the nutritional powder form the nutritional liquid. The nutritional liquid is expelled through the outlet aperture.
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IN-POD PRE-TREATMENT PHASE TO IMPROVE PREPARATION OF NUTRITIONAL LIQUIDS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to and any benefit of U.S. Provisional Application No. 62/026,997, filed July 21, 2014, the content of which is incorporated herein by reference in its entirety.

FIELD

[0002] The present disclosure relates generally to nutritional compositions and, more particularly, to systems and methods for rendering a nutritional composition housed in a container suitable for consumption, as well as to such containers.

BACKGROUND

[0003] It is known to reconstitute consumable powders with a liquid such as water to render the powders fit for consumption, for example, as a consumable liquid. For example, WO 2006/015689 (the entire disclosure of which is incorporated herein by reference) discloses reconstituting consumable powders with a liquid to provide a food liquid such as milk, cappuccino-type beverage, or soup. The consumable powder is introduced into a container and pre-wetted by introducing a wetting liquid stream into the container such that the wetting liquid stream intersects in mid-air with the powder as the powder is being introduced into the container. The pre-wetted powder is then mixed to form the food liquid by introducing a mixing liquid stream into the container.

SUMMARY

[0004] The general inventive concepts are based, at least in part, on the discovery that pre-treating a nutritional composition (e.g., a powder or concentrated liquid composition) stored in a sealed container, capsule, or the like (generally, a "pod") with a pre-treating fluid deposited into the container, prior to mixing the pre-treated composition with a reconstituting fluid, may promote improved processing of the nutritional composition into a reconstituted nutritional...
liquid formulation. This improved processing may include, for example, faster dissolution of a powder nutritional composition, more homogenous mixing of the composition, reduced contamination of a processing device used to process the nutritional liquid formulation, more efficient preparation of the nutritional liquid at an acceptable temperature, and reduced preparation time. In the case of a powder nutritional composition, this improved processing efficiency can result, for example, in improved dissolution of the powder nutritional composition in a reconstituting liquid (e.g., water), a shorter period of time until acceptable dissolution of the powder nutritional composition occurs, and/or a shorter period of time until an acceptable output characteristic (e.g., temperature) is achieved. In the case of a concentrated liquid nutritional composition, this improved processing efficiency can result, for example, in improved dilution of the concentrated liquid nutritional composition by a diluting liquid (e.g., water), a shorter period of time until acceptable dilution of the concentrated liquid nutritional composition occurs, and/or a shorter period of time until an acceptable output characteristic (e.g., temperature) is achieved.

[0005] According to various aspects of the present application, a pre-treating fluid may be distinguished from a reconstituting fluid by a variety of parameters, including, for example, fluid material, fluid inlet location/orientation, flow rate, flow velocity, fluid temperature, pressure, and timing of fluid introduction. In another exemplary embodiment, a pre-treating fluid may be introduced into a container before an outlet aperture is produced in the container, such that the pre-treating fluid mixes with or otherwise treats the nutritional composition within the container. In such an embodiment, the reconstituting fluid may be introduced into the container after the outlet aperture is produced, such that a mixture of the reconstituting fluid, the pre-treating fluid, and the nutritional composition passes through the outlet aperture.

[0006] In accordance with an exemplary aspect of the present application, a method for reconstituting a nutritional powder into a nutritional liquid is described. In the exemplary method, a container is provided with a hermetically enclosed chamber retaining a predetermined amount of the nutritional powder. At least one inlet aperture is produced in the container, the at least one inlet aperture being in fluid communication with the chamber. A first volume of pre-treating fluid is introduced through the at least one inlet aperture into the chamber to pre-treat the nutritional powder. An outlet aperture is produced in the container, the outlet aperture being in fluid communication with the chamber. A second volume of reconstituting fluid is introduced
through the at least one inlet aperture into the chamber, and the pre-treating fluid, the
reconstituting fluid, and the nutritional powder form the nutritional liquid. The nutritional liquid
is expelled through the outlet aperture.

[0007] In accordance with another exemplary aspect of the present application, a
system for reconstituting a nutritional powder into a nutritional liquid includes a container
including a hermetically enclosed chamber retaining a predetermined amount of the nutritional
powder; and a fluid delivery device configured to receive the container. The fluid delivery
device introduces a first volume of pre-treating fluid through at least one inlet aperture into the
chamber to pre-treat the nutritional powder. After introducing the pre-treating fluid into the
chamber, the fluid delivery device produces an outlet aperture in the container, the outlet
aperture being in fluid communication with the chamber. The fluid delivery device introduces a
second volume of reconstituting fluid through the at least one inlet aperture into the chamber,
with the pre-treating fluid, the reconstituting fluid, and the nutritional powder forming the
nutritional liquid. The fluid delivery device expels the nutritional liquid through the outlet
aperture.

BRIEF DESCRIPTION OF THE FIGURES

[0008] Other aspects and features of the general inventive concepts will become more
readily apparent to those of ordinary skill in the art upon review of the following description of
various exemplary embodiments in conjunction with the accompanying figures, wherein:

[0009] Figure 1 is a schematic cross-sectional view of a system for reconstituting a
nutritional powder into a nutritional liquid, according to an exemplary embodiment;

[0010] Figure 2 is a schematic cross-sectional view of another system for reconstituting
a nutritional powder into a nutritional liquid, according to an exemplary embodiment;

[0011] Figure 3 is a schematic cross-sectional view of a single serving pod of
nutritional powder, illustrating optional locations for one or more inlet apertures, according to
one or more exemplary embodiments;
[0012] Figure 4 is a schematic cross-sectional view of a single serving pod of nutritional powder, illustrating optional structural features for the pod, according to one or more exemplary embodiments;

[0013] Figure 5 is a schematic cross-sectional view of another system for reconstituting a nutritional powder into a nutritional liquid, according to an exemplary embodiment; and

[0014] Figure 6 is a schematic cross-sectional view of another single serving pod of nutritional powder, illustrating optional structural features for the pod, according to one or more exemplary embodiments.

DETAILED DESCRIPTION

[0015] This Detailed Description of the Invention merely describes exemplary embodiments of the invention and is not intended to limit the scope of the claims in any way. Indeed, the invention as claimed is broader than and unlimited by the preferred embodiments, and the terms used in the claims have their full ordinary meaning. For example, while many of the exemplary embodiments of the present application describe rigid, single use pods, systems, and processes for reconstituting an infant formula powder into a single serving of a liquid infant formula product, in other embodiments, one or more of the inventive features described herein may be applied to the preparation of a variety of orally consumable liquids, in a variety of volumes, from a variety of solid and/or liquid compositions from which a consumable liquid may be prepared, using a variety of composition storage structures. Other exemplary orally consumable liquids include hot or cold adult nutritional beverages, tea, coffee, soup, cocoa, juice. Other exemplary volumes include multiple serving sizes, fractional serving sizes, and user adjustable serving sizes. Other exemplary solid and/or liquid compositions include dissolvable solid tablets or cakes, capsules, concentrated liquids or syrups, slurries, or some combination thereof. Other exemplary composition storage structures include packets, bags, and re-usable or re-sealable containers.

[0016] The term "nutritional composition" as used herein, unless otherwise specified, refers to dissolvable solids (e.g., nutritional powders) and dilutable liquids (e.g., concentrated liquids). The nutritional powders may be reconstituted to form nutritional liquids suitable for
oral consumption by a human. The concentrated liquids may be diluted or otherwise augmented to form nutritional liquids suitable for oral consumption by a human. Examples of nutritional powders are disclosed in "HOT AND COLD WATER DELIVERY TO POD CONTAINING NUTRITIONAL COMPOSITION," filed on July 21, 2014, the entire disclosure of which is incorporated herein by reference.

[0017] The terms "powder," "reconstitutable," and "reconstitutable powder" as used herein, unless otherwise specified, each describe a physical form of a composition (including, but not limited to, a nutritional composition), or portion thereof, that is flowable or scoopable and can be reconstituted with water or other liquid prior to consumption.

[0018] The term "pod" as used herein, unless otherwise specified, refers to a hermetically sealed container including one or more chambers therein, wherein at least one of the chambers defines an internal volume containing a substantially soluble powder or liquid concentrate formulation that when mixed with a liquid, such as water, yields a food product or beverage (including, but not limited to, a nutritional food product or beverage). The pod, may, but need not, be specifically configured to house a single serving of the nutritional composition (e.g., a sufficient amount of nutritional composition to produce a single serving of a nutritional liquid, such as, for example, 1-8 ounces of infant formula, or any other suitable amount of any suitable nutritional or consumable liquid). In such an embodiment, the size of the pod may be minimized, while giving consideration to the amount of nutritional composition in the pod, desired bulk density, and mixing or reconstituting requirements, for example, to minimize packaging and facilitate storage and handling.

[0019] The term "reconstitute" as used herein, unless otherwise specified, refers to a process by which the nutritional powder is mixed with a liquid, typically water, to form an essentially homogeneous liquid product. Once reconstituted in the liquid, the ingredients of the nutritional powder may be any combination of one or more of dissolved, dispersed, suspended, colloidally suspended, emulsified, or otherwise blended within the matrix of the liquid product. Therefore, the resulting reconstituted liquid product, may be characterized as any combination of a solution, a dispersion, a suspension, a colloidal suspension, an emulsion, or a homogeneous
blend. A nutritional composition may be said to be "reconstituted" even if a nominal portion (e.g., less than 10%) of the powder remains un-reconstituted in the resulting liquid product.

[0020] The term "pre-treat" as used herein, unless otherwise specified, refers to a process by which a liquid and/or gaseous fluid is applied to the nutritional powder to partially reconstitute the powder and/or to prepare the powder for reconstitution (e.g., by deagglomerating clumps of nutritional powder) while the powder is retained in the pod chamber, before an outlet aperture is produced in the pod chamber. This pre-treating phase, when applicable, at least partially precedes a reconstituting phase in which a reconstituting liquid mixes with the pre-treated nutritional powder, to complete reconstitution of the nutritional composition as the reconstituting liquid enters the pod chamber, passes through an outlet aperture produced in the pod chamber, and is discharged into a serving container that collects the nutritional liquid.

[0021] The term "fluid flow" as used herein, unless otherwise specified, refers to movement of a fluid whether in response to manipulation of the fluid or in accordance with natural forces (e.g., gravity) acting thereon. The term "fluid flow" also encompasses movement of a fluid that has been reshaped or otherwise altered, such as atomization of a stream of liquid water.

[0022] All percentages, parts and ratios as used herein, are by weight of the total product, 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.

[0023] 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.

[0024] 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. Likewise, all individual embodiments and features thereof, as disclosed or suggested herein, may be combined in any manner consistent with the general
inventive concepts. Accordingly, the systems, methods, pods, and formulations may comprise, consist of, or consist essentially of the essential elements disclosed or suggested, as well as any additional or optional element disclosed or suggested herein or otherwise useful in such applications.

[0025] As noted above and schematically shown in Figure 1, a beverage preparation system 100 includes a pod 10 or other such container that includes one or more chambers 20 therein. A substantially soluble powder and/or liquid concentrate formulation (generally, a nutritional composition 5) is housed in at least one of the chambers. In an exemplary embodiment, an amount of infant formula nutritional powder sufficient for a single serving of 1 to 10 fluid ounces of reconstituted liquid formula (e.g., 2 g to 150 g, sufficient to produce 25 ml to 500 ml of nutritional liquid, or any other suitable amount, examples of which are provided below) is stored in the pod chamber. The pod 10 may be hermetically sealed (e.g., by a foil cover or membrane 30), for example, to prevent leakage of the nutritional composition, to protect the enclosed composition 5 from external contamination, and/or to retard degradation of the enclosed composition prior to use.

[0026] In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 100 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 60 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 50 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 35 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 30 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 25 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 20 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 15 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 2 g to 10 g.

[0027] In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 5 g to 100 g. In some embodiments, the amount of the reconstitutable...
powder in the pod is within the range of 5 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 5 g to 60 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 5 g to 50 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 5 g to 35 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 5 g to 30 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 5 g to 25 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 5 g to 20 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 5 g to 15 g.

[0028] In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 100 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 60 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 50 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 40 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 35 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 30 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 25 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 10 g to 20 g.

[0029] In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 15 g to 100 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 15 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 15 g to 60 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 15 g to 50 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 15 g to 40 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 15 g to 35 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 15 g to 30 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 15 g to 25 g.
In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 20 g to 100 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 20 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 20 g to 60 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 20 g to 50 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 20 g to 40 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 20 g to 35 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 20 g to 30 g.

In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 25 g to 100 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 25 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 25 g to 60 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 25 g to 50 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 25 g to 40 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 25 g to 35 g.

In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 30 g to 100 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 30 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 30 g to 60 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 30 g to 50 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 30 g to 40 g.

In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 40 g to 100 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 40 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 40 g to 60 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 40 g to 50 g.
In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 50 g to 100 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 50 g to 80 g. In some embodiments, the amount of the reconstitutable powder in the pod is within the range of 50 g to 60 g.

In some embodiments, the amount of the reconstitutable powder in the pod is approximately 8 g, 10 g, 12 g, 15 g, 20 g, 25 g, 30 g, 35 g, 40 g, 50 g, 60 g, 80 g, 90 g, 100 g, or 150 g.

In some embodiments, a bulk density of the reconstitutable powder in the pod is within the range of 0.3 g/cc to 0.8 g/cc.

In some embodiments, an average particle size of the reconstitutable powder in the pod is within the range of 10 microns to 500 microns.

In some embodiments, the liquid introduced into the pod to reconstitute the reconstitutable powder is water. In some embodiments, the volume of liquid introduced into the pod to reconstitute the reconstitutable powder is within the range of 1 fluid ounce to 10 fluid ounces. In some embodiments, the volume of liquid introduced into the pod to reconstitute the reconstitutable powder is 1 fluid ounce. In some embodiments, the volume of liquid introduced into the pod to reconstitute the reconstitutable powder is 2 fluid ounces. In some embodiments, the volume of liquid introduced into the pod to reconstitute the reconstitutable powder is 4 fluid ounces. In some embodiments, the volume of liquid introduced into the pod to reconstitute the reconstitutable powder is 8 fluid ounces. In some embodiments, the volume of liquid introduced into the pod to reconstitute the reconstitutable powder is greater than 10 fluid ounces. In some embodiments, the volume of liquid introduced into the pod to reconstitute the reconstitutable powder is within the range of 25 ml to 500 ml.

The pod 10 is used by inserting or otherwise interfacing the pod with a fluid delivery device 50. The hermetic seal of the pod 10 is then disrupted to produce at least one inlet aperture 32 in the pod, in fluid communication with the pod chamber 20. In some exemplary embodiments, the fluid delivery device 50 is operable to produce the at least one inlet aperture 32. For example, the fluid delivery device could use a mechanical means (e.g., a needle or
punch, pressurized air, or suction), shown schematically at 51, to puncture or otherwise produce
an aperture in the pod or some portion thereof (e.g., the membrane 30). As another example, the
fluid delivery device could use a mechanical means 51 (e.g., a moving arm) to lift a sealing
member or break or detach a frangible portion of the pod (e.g., a perforated portion of the
membrane 30). As another example, shown in Figure 2, an inlet valve 31a (e.g., a one-way
valve) on the exterior of the pod 10a may be coupled to the fluid delivery device 50a and opened
to produce to inlet aperture 32a. In some exemplary embodiments, the user disrupts the hermetic
seal of the pod to produce the inlet aperture. For example, the user could manually remove a
sealing member or break a frangible or perforated portion of the pod to produce the inlet
aperture. In some exemplary embodiments, merely interfacing the pod with the fluid delivery
device will remove or disrupt the hermetic seal of the pod.

[0040] Once the hermetic seal of the pod 10 is removed or disrupted to produce at least
one inlet aperture 32 in the pod, the fluid delivery device 50 introduces one or more fluid flows
from one or more fluid sources 55 (e.g., a reservoir or conduit) of the fluid delivery device into
the chamber 20 of the pod 10. In some exemplary embodiments, a single fluid flow is
introduced into the pod. In some exemplary embodiments, two fluid flows are introduced into
the pod (simultaneously and/or sequentially). In some exemplary embodiments, more than two
fluid flows are introduced into the pod (simultaneously and/or sequentially).

[0041] As the fluid flows are introduced into the pod, at least one of the fluid flows
contacts a formulation enclosed in the pod to render the formulation suitable for oral
consumption. In some exemplary embodiments, the formulation is a nutritional composition. In
some exemplary embodiments, the nutritional composition is a reconstitutable powder. In some
exemplary embodiments, the reconstitutable powder is infant formula. In some exemplary
embodiments, the nutritional composition is a concentrated liquid.

[0042] The general inventive concepts encompass various innovations which improve
the efficiency of processing of the formulation enclosed within the pod to render it suitable for
oral consumption. In the case of a powder nutritional composition, this improved processing
efficiency can result, for example, in improved dissolution of the powder nutritional composition
in a reconstituting liquid (e.g., water), a shorter period of time until acceptable reconstitution of
the powder nutritional composition occurs, and/or a shorter period of time until an acceptable output temperature is achieved. In the case of a concentrated liquid nutritional composition, this improved processing efficiency can result, for example, in improved dilution of the concentrated liquid nutritional composition by a diluting liquid (e.g., water), a shorter period of time until acceptable dilution of the concentrated liquid nutritional composition occurs, and/or a shorter period of time until an acceptable output temperature is achieved.

[0043] In one embodiment of the present application, the pod 10 may include an internal chamber or chambers 20 having an internal volume that is sufficient to store the nutritional composition 5 and to receive a portion of the fluid flow of reconstituting fluid F2, but insufficient to retain an entirety of the fluid that is to be combined with the nutritional composition to form the completed single serving of nutritional liquid L. The reduced size of the chamber 20 allows for a smaller pod size, for example, to reduce pod material and packaging costs, and to facilitate storage and handling.

[0044] To allow for introduction of the entirety of the higher volume fluid F2 into the lower volume pod chamber or chambers 20 during preparation of the nutritional liquid, an outlet aperture 34 is produced in the pod, in fluid communication with the one or more chambers, to allow for flow of the added fluid F2 from the fluid source 55, along with the nutritional composition 5, through the chamber 20 and through the outlet aperture 34, and into a serving container 80 (e.g., a bottle or cup). The fluid delivery device 50 and pod 10 may be configured such that the nutritional composition 5 is partially mixed, emulsified, dissolved, or otherwise reconstituted in the reconstituting fluid F2 within the pod 10 and within a discharge stream S of the fluid between the pod 10 and the serving container 80, with a final portion of the nutritional composition being reconstituted within the serving container 80. In such an arrangement, a first portion of the nutritional composition (e.g., 50% - 90%) is reconstituted in the pod, a second portion of the nutritional composition (e.g., 5% - 20%) is reconstituted in the discharge stream S, and a third portion of the nutritional composition (e.g., 5% - 20%) is reconstituted in the serving container. In some embodiments, a fourth portion of the nutritional composition (e.g., up to 10%) may remain un-reconstituted in the pod chamber and/or in the serving container.
[0045] To facilitate earlier, faster, more uniform, and/or more complete reconstituting of the nutritional composition, in accordance with an exemplary aspect of the present application, a first fluid flow F1 may be added to the pod chamber 20 from a fluid source 55 of the fluid delivery device 50 to pre-treat the nutritional composition 5 while the nutritional composition is retained in the pod chamber 20, for example, to partially reconstitute the nutritional composition 5 or to prepare the nutritional composition for reconstitution. This pre-treating of the nutritional composition 5 may include, for example, deagglomeration of clumps of nutritional powder, increasing porosity or decreasing bulk density of the nutritional powder, heating of the nutritional composition, or partial dissolution, emulsifying, dispersal, suspension, blending, slurrying, or other such partial reconstitution of the nutritional powder. This pre-treating of the nutritional powder may occur before the outlet aperture 34 is produced in the pod 10, such that complete pre-treatment of the nutritional powder 5 occurs within the pod chamber 20. In some exemplary embodiments, an entirety of the pre-treatment phase occurs before the outlet aperture is produced in the pod. In other exemplary embodiments, a portion of the pre-treatment phase occurs before the outlet aperture is produced in the pod, with the outlet aperture being produced during (for example, towards the completion of) the pre-treatment phase. In yet another exemplary embodiment, the pre-treating fluid flow is introduced into the pod chamber through an aperture that is subsequently used as an outlet aperture (but is effectively an inlet aperture as the pre-treating fluid is introduced into the pod chamber).

[0046] Many different types of fluid may be utilized to pre-treat the nutritional composition stored within the pod chamber, including, for example, one or more of liquid water, steam, and air (including humid or high moisture air). In one such example, a pre-treating fluid flow of air, nitrogen, or other suitable inert gas may be applied to the nutritional powder within the pod to deagglomerate, "fluff up," increase the porosity of, or decrease the bulk density of the nutritional powder. The gas flow may be pressurized (e.g., at pressures within a range of 200 mbar to 15,000 mbar, or any other suitable pressure) to more fully pre-treat the nutritional powder within the pod chamber. Such pre-treatment may facilitate the subsequent flow of water through the nutritional powder to wet the powder more quickly and/or more uniformly, and may reduce the amount of unreconstituted powder remaining caked within the pod when the nutritional liquid is produced.
[0047] In another exemplary embodiment, ionized air or another suitable ionized fluid may be introduced into the pod chamber as a pre-treating fluid, for example, to attract nutritional powder particles to the charged gas ions to deagglomerate, "fluff up," increase the porosity of, or decrease the bulk density of the nutritional powder.

[0048] In another example, a pre-treating fluid flow of liquid water may be applied to the nutritional powder within the pod to partially reconstitute the nutritional powder while the nutritional powder is retained in the pod chamber, such that a greater percentage of the nutritional powder is reconstituted when the outlet aperture is produced and the mixture of reconstituting fluid and nutritional powder are passed through the outlet aperture. The pre-treating liquid water may partially dissolve, emulsify, disperse, suspend, or blend the nutritional powder within the pre-treating water, which may produce a partially reconstituted slurry within the pod chamber. In some such embodiments, the liquid water pre-treating fluid flow may be pressurized, for example, to increase the diffusion of the applied liquid water through the nutritional powder, and/or to deagglomerate, increase the porosity of, or decrease the bulk density of the nutritional powder, as described above.

[0049] In still another example, a pre-treating fluid flow may include a mixture or combination of liquid water and air or other suitable gas, such as, for example, moist or humid air, steam, or alternating or concurrent fluid flows of air and liquid water through one or more inlet apertures. Such pre-treating fluids may deagglomerate, "fluff up," increase the porosity of, or decrease the bulk density of the nutritional powder, as well as partially reconstitute the nutritional powder while the nutritional powder is retained in the pod chamber, as described above. Further, the gas may be pressurized to facilitate greater penetration of the liquid water into the stored nutritional composition.

[0050] While the pre-treating fluid FL may be introduced into the pod chamber 20 through an inlet aperture 32 in a top surface of the pod 20 (as oriented within the fluid delivery device 50), as shown in Figure 1, in other exemplary embodiments, shown in Figure 3, the pre-treating fluid may additionally or alternatively be applied through one or more inlet apertures 32bi, 32b2, 32b3 provided at other locations on the pod chamber 10b, including, for example, side or bottom surfaces of the pod 10b. In another example, the inlet aperture or apertures 32b4
may be at least partially disposed in a valve or conduit 31b extending into the chamber, such that
the pre-treating fluid is introduced into the chamber and applied to the nutritional composition
from a location within the pod. In another exemplary embodiment, the pre-treating fluid is
introduced into the chamber through two or more inlet apertures (e.g., 32b, 32bi, 32b2, 32b3,
32b4, 32b5) produced in the pod 10b, for example, to more uniformly expose the stored
nutritional composition 5 to the pre-treating fluid F1. The multiple inlet apertures may be spaced
apart on a common surface of the pod (e.g., on the upper surface) or positioned to orient the pre-
treating fluid flows in multiple directions into the pod chamber (e.g., at different locations on a
side wall around an outer periphery of the pod, or on two or more of the top, bottom, and side
walls of the pod).

[0051] In some exemplary embodiments, a vent aperture 33 may also be produced in
the pod to permit air contained within the hermetically sealed pod 10 to vent from the pod
chamber 20 as the pre-treating fluid F1 is introduced into the pod chamber. In some exemplary
embodiments, the fluid delivery device 50 is operable to produce the vent aperture 33. For
example, the fluid delivery device could use a mechanical means (e.g., a needle or punch,
pressurized air, or suction), shown schematically at 53, to puncture or otherwise produce an
aperture in the pod or some portion thereof (e.g., the membrane 30). As another example, the
fluid delivery device could use a mechanical means 53 (e.g., a moving arm) to lift a sealing
member of break a frangible portion of the pod (e.g., a perforated portion of the membrane 30).
As another example, shown in Figure 2, a valve 35a in the pod 10a (e.g., a pressure relief valve
or one-way valve) may automatically open to produce the vent aperture 33a upon introduction of
the pre-treating fluid flow F1 to vent air from the pod chamber 20a. The venting valve 35a may
be configured to remain closed unless and until pressure within the pod chamber 20a exceeds a
predetermined threshold (e.g., 200 mbar to 15,000 mbar, or any other suitable pressure). In
exemplary embodiments in which the pre-treating fluid is at least partially a gas, the pre-treating
gas may also be permitted to vent through the vent aperture 33a. In such embodiments, the vent
aperture may be provided with a filter component 29a to allow for evacuation of the air and/or
pre-treating gas while retaining the nutritional powder 5a in the pod chamber 20a. The gases
vented from the pod chamber may be vented, expelled, or otherwise processed by the fluid
delivery device 50a.
[0052] Once the pre-treatment of the nutritional composition within the pod chamber has commenced and/or concluded, the outlet aperture 34 may be produced in the pod 10 to allow for passage of the reconstituting fluid flow F2. In some exemplary embodiments, the fluid delivery device 50 is operable to produce the outlet aperture 34. For example, the fluid delivery device could use a mechanical means (e.g., a needle or punch, pressurized air, or suction), shown schematically at 54, to puncture or otherwise produce an aperture in the pod or some portion thereof (e.g., a lower foil seal or membrane 37). As another example, the fluid delivery device could use a mechanical means 54 (e.g., a moving arm) to lift, break or otherwise detach a sealing member or frangible portion of the pod (e.g., a perforated portion of the lower membrane 37). As another example, as shown in Figure 2, a valve 36a (e.g., a one-way valve) disposed on the pod 10a may be actuated by the fluid delivery device 50a or otherwise opened to produce outlet aperture 34a, or may be configured to automatically open upon pressurization of the pod chamber to a predetermined pressure threshold (e.g., 200 mbar to 15,000 mbar, or any other suitable pressure) to produce the outlet aperture 34a upon introduction of a sufficient amount of the pre-treating fluid flow F1 and/or the reconstituting fluid flow F2. In the illustrated schematic example, the outlet aperture 34 is located on a bottom surface of the pod 10 in alignment with the serving container 80, to allow for direct passage of the discharge stream S to the serving container without contacting other portions of the fluid delivery device 50. In other embodiments (not shown), the outlet aperture may be located on another surface of the body (e.g., a top or side surface of the pod). In still other exemplary embodiments (not shown), multiple outlet apertures (on one or more surfaces of the pod) may be produced. In other embodiments, the discharged liquid L may pass through additional processing portions of the fluid delivery device to further alter the liquid (e.g., by heating, cooling, sterilizing pressurizing, carbonating, or adding additional substances to the liquid).

[0053] In some embodiments, the inlet, outlet, and vent apertures are fully defined by holes formed in a frangible or perforated exterior membrane or membranes of the pod. In other exemplary embodiments, the inlet, outlet, and/or vent apertures may be at least partially defined by internal or external structural portions of the pod, including, for example, valves, channels, couplings, filters, diffusers, atomizers, or other such structures. These structures, in addition to permitting passage of pre-treating fluid, reconstituting fluid, and/or vented fluid into and/or out of the pod chamber, may further direct, filter, regulate, or otherwise control these fluid flows.
Exemplary pod structures are described in co-pending provisional application titled "POD WITH BUILT-IN INLET FLUID PORTS TO INCREASE MIXING," filed on July 21, 2014 the entire disclosure of which is incorporated herein by reference. In other embodiments, the fluid delivery device may include additional structure or mechanisms that direct, filter, regulate, or otherwise control the fluid flows into the pod chamber, in addition to or instead of such structures or mechanisms provided in the pod.

[0054] In another example, a pod may be provided with structure to spread or diffuse a pre-treating fluid throughout the interior of the pod chamber, examples of which are schematically illustrated in Figure 4. As one example, one or more inlet apertures 32ci, 32c2, 32c3 into the pod chamber may be obliquely oriented through the pod wall or angled with respect to the pod wall, such that the pre-treating fluid flow F1 is directed across a greater portion of the stored nutritional composition 5c (as described in greater detail in the above incorporated "POD WITH BUILT-IN INLET FLUID PORTS TO INCREASE MIXING" application). As another example, internal surfaces of the pod chamber may include one or more discontinuities 36c selected to enhance dispersion of the pre-treating fluid within the chamber. These discontinuities may include for example, one or more baffles, ribs, protuberances, pockets, or grooves. As still another example, the pod may include inlet ports, nozzles 38c or other such structure configured to diffuse, atomize, or otherwise spread the pre-treating fluid flow F1 within the chamber, producing, for example, a cone, sheet, or mist of fluid flow into the chamber. This structure may be assembled with, welded to, or otherwise attached to the container. Examples of atomizing inlet apertures or ports are described in co-pending provisional application titled "POD WITH SPRAY NOZZLE AND METHOD OF USE," filed on July 21, 2014, the entire disclosure of which is incorporated herein by reference.

[0055] The reconstituting fluid flow F2 may (but need not) be introduced into the pod chamber 20 through the same inlet aperture or apertures 32 used to introduce the pre-treating fluid flow F1 into the pod chamber. In exemplary embodiments in which the pre-treating fluid flow F1 and the reconstituting fluid flow F2 are both liquid water, the fluid flows F1, F2 may (but need not) be supplied from the same fluid source 55 of the fluid delivery device 50. In some such embodiments, the pre-treating fluid flow F1 and the reconstituting fluid flow F2 may be first and second portions of a single continuous fluid flow, with the first (pre-treating) portion of
the fluid flow being defined by the portion of the fluid flow supplied to the pod chamber before
the outlet aperture is produced in the pod chamber, and the second (reconstituting) portion of the
fluid flow being defined by the portion of the fluid flow supplied to the pod chamber after the
outlet aperture is produced in the pod chamber.

[0056] In other exemplary embodiments, as shown in Figure 5, the reconstituting fluid
flow F2 may be introduced into the pod chamber 20d through a different inlet aperture or
apertures 32d' than the inlet aperture or apertures 32d used to introduce the pre-treating fluid
flow Fl into the pod chamber 20. The inlet aperture or apertures 32d' used to introduce the
reconstituting fluid flow F2 into the pod chamber 20d may be produced (e.g., using one or more
of the inlet aperture producing structures and methods described above) at the same time as the
inlet aperture or apertures 32d used to introduce the pre-treating fluid flow Fl into the pod
chamber 20d, or the inlet apertures 32d' may be produced after introduction of the pre-treating
fluid flow Fl into the pod chamber 20d and immediately prior to introduction of the
reconstituting fluid flow F2 into the pod chamber 20d. In still other exemplary embodiments, the
reconstituting fluid flow F2 may be introduced into the pod chamber 20d through the vent
aperture 33d, such that the vent aperture 33d is effectively the reconstituting fluid inlet aperture.
In other exemplary embodiments, the pre-treating fluid inlet aperture may serve as a vent
aperture during introduction of the reconstituting fluid through the reconstituting fluid inlet
aperture.

[0057] In exemplary embodiments in which the pre-treating fluid flow Fl and the
reconstituting fluid flow F2 are supplied to the pod chamber through different inlet apertures, the
fluid flows Fl, F2 may (but need not) be supplied from different fluid sources 55d, 55d' of the
fluid delivery device 50d. In such embodiments, the pre-treating and reconstituting fluid flows
Fl, F2 may comprise different types of fluid, for example, a pre-treating fluid flow Fl of air,
moist air, or steam and a reconstituting fluid flow F2 of liquid water. In other such
embodiments, the pre-treating and reconstituting fluid flows Fl, F2 may comprise fluids having
differing properties, such as, for example, temperature, pressure, flow rate, and flow velocity. In
one exemplary embodiment, the pre-treating fluid Fl may be provided at a higher temperature
(e.g., 20 degrees C to 120 degrees C, or any other suitable "high" temperature range), for
example, to accelerate initial dissolution or emulsifying of the nutritional powder, and the
reconstituting fluid F2 may be provided at a lower temperature (e.g., 5 degrees C to 50 degrees C, or any other suitable "low" temperature range), for example, to produce a nutritional liquid (e.g., infant formula) at a temperature suitable for immediate consumption or requiring a shorter period of time for the liquid to cool to a suitable temperature (e.g., 25 degrees C to 50 degrees C for infant formula, 5 degrees C to 15 degrees C for iced tea, or any other suitable temperature). The use of multiple fluid flows having different or varying temperatures to product a reconstituted nutritional liquid of a desired temperature is described in greater detail in the above incorporated "HOT AND COLD WATER DELIVERY TO POD CONTAINING NUTRITIONAL COMPOSITION" application. In another exemplary embodiment, the pre-treating fluid F1 may be supplied at a different flow rate than the reconstituting fluid, for example, to optimize in-pod partial reconstitution of the nutritional powder and subsequent through-pod reconstitution of the partially reconstituted slurry. For example, the pre-treating fluid may be supplied at a lower flow rate, as compared to the subsequent reconstituting fluid, to promote even distribution of the fluid and/or to minimize caking of the powder. In one exemplary embodiment, pre-treating and reconstituting fluids having different properties (e.g., temperature, flow rate) may be supplied from the same fluid source of the fluid delivery device, with the fluid delivery device including mechanisms (e.g., heating elements, cooling elements, flow control valves) to alter the properties of the fluid supplied from the fluid source to provide the differing properties.

[0058] The volumes of the pre-treating and reconstituting fluid flows F1, F2 introduced into the pod can be varied or otherwise selected to be different to achieve, or at least contribute to achievement of, the aforementioned improved processing efficiency. In exemplary embodiments in which the pre-treating fluid flow is liquid water for partially reconstituting the nutritional composition, the volume of the pre-treating fluid is a fraction of the total volume of the final nutritional liquid L, and may be limited by the internal volume of the pod chamber and the volume of the nutritional composition stored within the pod chamber. As such, in some exemplary embodiments, the total volume of pre-treating fluid is less than or equal to the total volume of reconstituting fluid (e.g. within the range of 10% to 100% of the total volume of reconstituting fluid, or any other suitable fraction of the total volume of the reconstituting fluid). In an exemplary embodiment, the pod chamber has an internal volume sufficient to provide a headspace of 10% to 40% (i.e., the nutritional powder occupying 60% to 90% of the chamber.
volume), the pre-treating fluid F1 has a total volume of 0.1 to 5 fluid ounces, and the reconstituting fluid F2 has a total volume of 1 to 10 fluid ounces, with the finished nutritional liquid having a total volume of approximately 1 to 10 fluid ounces. In exemplary embodiments in which the pre-treating fluid flow includes air or some other suitable gas, larger volumes of the pre-treating fluid F1 may be used, as this pre-treating gas is vented from the pod and does not contribute significantly to the volume of the nutritional liquid L.

[0059] Typically, a predetermined volume of fluid is needed to render the formulation enclosed in the pod suitable for oral consumption. The fluid delivery device may be configured to deliver the needed amount of fluid to the pod, for example, based on user input or by reading or otherwise processing indicia on the pod itself. The fluid delivery device may be configured to receive and process pods of a variety of shapes and sizes, for example, to accommodate preparations of nutritional liquids of varying serving size (e.g., varying infant formula serving sizes for a wider age range). In some exemplary embodiments, where a range of volumes of fluid will suffice to render the formulation enclosed in the pod suitable for oral consumption, the user may be able to select a desired volume of fluid within the range of acceptable volumes of fluid. Based on these inputs, the fluid delivery device 50 may be configured to proportionally adjust the corresponding volumes of pre-treating fluid F1 and reconstituting fluid F2 supplied to the pod 10, to provide suitable pre-treatment and reconstituting of the nutritional composition, as well as desired temperature and process time of the nutritional liquid. Additionally or alternatively, the fluid delivery device 50 may be configured to proportionally adjust the temperatures, flow rates, and other such properties of the finished nutritional liquid.

[0060] According to an aspect of the present application, the pre-treating fluid may be supplied to the pod chamber over a first period of time (e.g., 1 to 30 seconds, or any other suitable time period) and the reconstituting fluid may be supplied to the pod chamber over a second period of time (e.g., 1 to 60 seconds, or any other suitable time period) different from the first period of time. While any suitable time periods may be utilized, in an exemplary embodiment, the first (pre-treating) time period is shorter than the second (reconstituting) time period. In one such exemplary embodiment, the first and second time periods may partially overlap. In another exemplary embodiment, the first and second time periods may be separate time periods that do not overlap. In still another exemplary embodiment, the first and second
time periods may be separated by a third time period (e.g., a delay or pause between the pre-treating phase and the reconstituting phase). This third time period may allow time, for example, for producing the outlet aperture, for further reconstituting the nutritional powder with the added pre-treating fluid, or for allowing the partially reconstituted composition to cool. While any suitable time periods may be utilized, in an exemplary embodiment, the first (pre-treating) time period is within the range of 1 to 30 seconds, the second (reconstituting) time period is within the range of 1 to 60 seconds, and the third (delay) time period is within the range of 1 to 15 seconds. In one such embodiment, a total time from a beginning of the first (pre-treating) time period to an end of the second (reconstituting) time period is within the range of 30 to 90 seconds, or some other suitable process time for producing the reconstituted nutritional liquid.

[0061] In an exemplary embodiment, the pre-treating fluid flow F1 and the reconstituting fluid flow F2 are continuous fluid flows during the respective first and second time periods. In other exemplary embodiments, either or both of the pre-treating fluid flow F1 and the reconstituting fluid flow F2 may be intermittent fluid flows during the respective time periods, from one or more than one of the at least one inlet aperture. In still other exemplary embodiments, either or both of the pre-treating fluid flow F1 and the reconstituting fluid flow F2 may include more than one type of fluid stream into one or more of the at least one inlet aperture. As one example, a pre-treating fluid flow F1 may include a first stream of a deagglomerating gas through a first inlet aperture and a second stream of a partially reconstituting or slurrying liquid water through a second inlet aperture. In other exemplary embodiments, either or both of the pre-treating fluid flow F1 and the reconstituting fluid flow F2 may include one or more fluid streams having different or varying fluid properties, such as, for example, temperature, flow rate, flow velocity, pressure, volume, input location, input direction, delivery time, and combinations thereof.

[0062] In the above described exemplary embodiments, the inlet, outlet, and vent apertures are produced in the pod such that the apertures extend directly into the pod chamber storing the nutritional composition, such that the pre-treating and reconstituting fluids are introduced directly into the pod chamber through the inlet aperture or apertures, the prepared liquid is expelled directly from the pod chamber through the outlet aperture, and the venting fluid is vented directly from the pod chamber through the vent aperture. In other exemplary
embodiments, as shown, for example, in Figure 6, a pod 10e may include one or more inlet, outlet, and vent apertures 32e, 34e, 33e be separated from (but still in fluid communication with) the nutritional composition storing pod chamber 20e by one or more intermediary chambers 22e, 24e, which may be vertically and/or laterally separated from the composition chamber 20e. In one such example, one or more intermediary chambers 24e between the pod apertures 32e, 33e, 34e and the nutritional composition chamber may function as a barrier between the aperture producing structure 52e, 53e, 54e (e.g., a needle or punch) and the nutritional composition 5e, for example, to prevent contamination of the aperture producing structure by the nutritional composition 5e, or to prevent contamination of the composition chamber 20e by the aperture producing structure 52e, 53e, 54e. Additionally or alternatively, an intermediary chamber may be provided with a filter, one way valve, flow regulator, or other such fluid controlling component 25e, 27e to modify or otherwise control the fluid flowing into or out of the composition chamber 20e.

[0063] In still other exemplary embodiments, other processes or conditions may be provided to "pre-treat" the nutritional composition within a single serving pod or other such container, in addition to or instead of the introduction of a pre-treating fluid into the pod. As one example, the fluid delivery device may be configured to subject the installed pod to a mechanical or ultrasonic vibration operation, for example, to deagglomerate, "fluff up," increase the porosity of, or decrease the bulk density of the nutritional powder. This vibration operation may be performed before and/or during the supplying of a pre-treating or reconstituting fluid into the pod. As another example, nutritional powder particles within the pod chamber may be electrostatically charged or ionized by the fluid delivery device in a charging operation, for example, to deagglomerate, "fluff up," increase the porosity of, or decrease the bulk density of the nutritional powder. The nutritional powder may include different material particles configured to disperse or repel from each other upon the introduction of an electrostatic charge. In yet another exemplary embodiment, the pod may be provided with a wetting agent, emulsifier or other surfactant that is mixed with the nutritional powder in an initial pre-treating operating (e.g., introduced into the composition chamber from a separate chamber within the pod. In still another exemplary embodiment, a non-stick or friction reducing material or film may be applied to the internal surfaces of the pod chamber to reduce the surface tension between the internal surfaces and the stored nutritional power.
[0064] To the extent that the terms "include," "includes," or "including" are used in the specification or the claims, they are intended to be inclusive in a manner similar to the term "comprising" as that term is interpreted when employed as a transitional word in a claim. Furthermore, to the extent that the term "or" is employed (e.g., A or B), it is intended to mean "A or B or both A and B." When the applicants intend to indicate "only A or B but not both," then the term "only A or B but not both" will be employed. Thus, use of the term "or" herein is the inclusive, and not the exclusive use. In the present disclosure, the words "a" or "an" are to be taken to include both the singular and the plural. Conversely, any reference to plural items shall, where appropriate, include the singular.

[0065] 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.

[0066] All ranges and parameters, including but not limited to percentages, parts, and ratios, disclosed herein are understood to encompass any and all sub-ranges assumed and subsumed therein, and every number between the endpoints. For example, a stated range of "1 to 10" should be considered to include any and all subranges between (and inclusive of) the minimum value of 1 and the maximum value of 10; that is, all subranges beginning with a minimum value of 1 or more (e.g., 1 to 6.1), and ending with a maximum value of 10 or less (e.g., 2.3 to 9.4, 3 to 8.4 to 7), and finally to each number 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 contained within the range.

[0067] 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.

[0068] The nutritional compositions may comprise, consist of, or consist essentially of the elements of the nutritional compositions as described herein, as well as any additional or optional element described herein or otherwise useful in nutritional composition applications.
While various inventive aspects, concepts and features of the inventions may be described and illustrated herein as embodied in combination in the exemplary embodiments, these various aspects, concepts and features may be used in many alternative embodiments, either individually or in various combinations and sub-combinations thereof. Unless expressly excluded herein all such combinations and sub-combinations are intended to be within the scope of the present inventions. Still further, while various alternative embodiments as to the various aspects, concepts and features of the inventions—such as alternative materials, structures, configurations, methods, circuits, devices and components, software, hardware, control logic, alternatives as to form, fit and function, and so on—may be described herein, such descriptions are not intended to be a complete or exhaustive list of available alternative embodiments, whether presently known or later developed. Those skilled in the art may readily adopt one or more of the inventive aspects, concepts or features into additional embodiments and uses within the scope of the present inventions even if such embodiments are not expressly disclosed herein. Additionally, even though some features, concepts or aspects of the inventions may be described herein as being a preferred arrangement or method, such description is not intended to suggest that such feature is required or necessary unless expressly so stated. Still further, exemplary or representative values and ranges may be included to assist in understanding the present disclosure; however, such values and ranges are not to be construed in a limiting sense and are intended to be critical values or ranges only if so expressly stated. Moreover, while various aspects, features and concepts may be expressly identified herein as being inventive or forming part of an invention, such identification is not intended to be exclusive, but rather there may be inventive aspects, concepts and features that are fully described herein without being expressly identified as such or as part of a specific invention. Descriptions of exemplary methods or processes are not limited to inclusion of all steps as being required in all cases, nor is the order that the steps are presented to be construed as required or necessary unless expressly so stated.
CLAIMS:

1. A method for reconstituting a nutritional powder into a nutritional liquid, the method comprising:
   providing a container including a hermetically enclosed chamber retaining a predetermined amount of the nutritional powder;
   producing at least one inlet aperture in the container, the at least one inlet aperture being in fluid communication with the chamber;
   introducing a first volume of pre-treating fluid through the at least one inlet aperture into the chamber to pre-treat the nutritional powder;
   after introducing the pre-treating fluid into the chamber, producing an outlet aperture in the container, the outlet aperture being in fluid communication with the chamber;
   introducing a second volume of reconstituting fluid through the at least one inlet aperture into the chamber, wherein the pre-treating fluid, the reconstituting fluid, and the nutritional powder form the nutritional liquid;
   expelling the nutritional liquid through the outlet aperture.

2. The method of claim 1, wherein the pre-treating fluid comprises liquid water.

3. The method of claim 1, wherein the pre-treating fluid comprises steam.

4. The method of claim 1, wherein the pre-treating fluid comprises air.

5. The method of claim 1, wherein the reconstituting fluid comprises water.

6. The method of claim 1, wherein the pre-treating fluid is introduced into the container over a first period of time, the reconstituting fluid is introduced into the container over a second period of time separate from the first period of time.

7. The method of claim 6, wherein the second period of time is greater than the first period of time.
8. The method of claim 6, wherein the first period of time is separated from the second period of time by a third period of time within the range of 1 second to 15 seconds.

9. The method of claim 1, wherein the total fluid introduced into the container is within the range of 25 ml to 500 ml.

10. The method claim 1, wherein the pre-treating fluid is introduced into the chamber at a first temperature and the reconstituting fluid is introduced into the chamber at a second temperature lower than the first temperature.

11. A system for reconstituting a nutritional powder into a nutritional liquid, the system comprising:
   a container including a hermetically enclosed chamber retaining a predetermined amount of the nutritional powder; and
   a fluid delivery device configured to receive the container;
   wherein the fluid delivery device introduces a first volume of pre-treating fluid through at least one inlet aperture in the container into the chamber to pre-treat the nutritional powder;
   wherein the fluid delivery device introduces a second volume of reconstituting fluid through the at least one inlet aperture into the chamber, wherein the pre-treating fluid, the reconstituting fluid, and the nutritional powder form the nutritional liquid;
   wherein the fluid delivery device produces an outlet aperture in the container after introducing the pre-treating fluid into the chamber, the outlet aperture being in fluid communication with the chamber; and
   wherein the fluid delivery device expels the nutritional liquid through the outlet aperture.

12. The system of claim 11, wherein the pre-treating fluid comprises liquid water.

13. The system of claim 11, wherein the pre-treating fluid comprises steam.

14. The system of claim 11, wherein the pre-treating fluid comprises air.
15. The system of claim 11, wherein the reconstituting fluid comprises water.

16. The system of claim 11, wherein the pre-treating fluid is introduced into the container over a first period of time, the reconstituting fluid is introduced into the container over a second period of time separate from the first period of time.

17. The system of claim 16, wherein the second period of time is greater than the first period of time.

18. The system of claim 16, wherein the first period of time is separated from the second period of time by a third period of time within the range of 1 second to 15 seconds.

19. The system of claim 11, wherein the total fluid introduced into the container is within the range of 25 ml to 500 ml.

20. The system of claim 11, wherein the fluid delivery device introduces the pre-treating fluid into the chamber at a first temperature and introduces the reconstituting fluid into the chamber at a second temperature lower than the first temperature.
**INTERNATIONAL SEARCH REPORT**

**International application No**

PCT/US2015/041377

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<td>EP 2 001 343 A2 (TUTTOESPRESSO SPA [IT]) 17 December 2008 (2008-12-17) paragraph [0042] - paragraph [0096]; claims; figures; examples</td>
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Further documents are listed in the continuation of Box C. See patent family annex.

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*"Supplementary Search Report"*

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Tel. (+31-70) 340-2040,
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