

BEVERAGE OR FOODSTUFF CONTAINER AND PREPARATION SYSTEM

TECHNICAL FIELD

The present disclosure relates to electrically operated beverage or foodstuff preparation systems, with which a beverage or foodstuff is prepared from a pre-portioned capsule.

BACKGROUND

Systems for the preparation of a beverage comprise a beverage preparation machine and a capsule. The capsule comprises a single-serving of a beverage forming precursor material, e.g. ground coffee or tea. The beverage preparation machine is arranged to execute a beverage preparation process on the capsule, typically by the exposure of pressurized, heated water to said precursor material. As part of this preparation process, the capsule is guided through the machine by a series of complex interactions to load, process and eject the capsule, by various mechanisms of the machine and principally a flange portion of the capsule. Processing of the capsule in this manner causes the at least partial extraction of the precursor material from the capsule as the beverage.

This configuration of beverage preparation machine has increased popularity due to enhanced user convenience compared to conventional beverage preparation machines (e.g. compared to a manually operated Moka pot/stove-top espresso maker).

Due to the complex movement of the capsule through the machine and the exposure to pressurized, heated water, to date only an aluminium based capsule has been implemented with a high degree of reliability. Indeed, other materials have been found to be prone to sticking in the machine or cause other material related errors. It would be desirable to be able to implement the capsule with less of a materials restriction.

Therefore, in spite of the effort already invested in the development of said capsule further improvements are desirable.

SUMMARY

The present disclosure provides a container for use with a machine for preparing a beverage and/or foodstuff or a precursor thereof, the container including: a storage portion comprising a cavity with a sidewall, a flange portion and a base for containing a precursor material, and a closing member to close the storage portion.

In embodiments, at least the storage portion, is formed of wood pulp-based material, and the storage portion comprises two or more of:

- a perforation region, arranged at the base of the storage portion, which is treated to facilitate comparatively easier perforation by a penetrator of the machine than a portion that is not treated;
- stiffener portions, arranged to extend along the base from a periphery to contiguous the perforation region to stiffen the base to resist displacement when the base is perforated by a penetrator of the machine; and
- a shoulder that extends outwardly from the flange portion to a rim of the sidewall proximal the base, to define a void defining region of the sidewall that is arranged between the shoulder and the base to increase the rigidity of the base.

The combination of the above features leads to optimised positioning, perforation, behaviour and disengagement of the container during insertion of the container and extraction of the precursor material contained in the container.

The rigidity of the container, especially of the base region of the container is improved when compared to a container having only one of these feature.

By treating a wood pulp-based container so that it is more easily perforated a reliability of such containers when used in the machine may be improved. For example, a condition where a wood pulp-based capsule has absorbed water at the perforation region causing it to deform with the penetrator rather than be perforated by the penetrator may be minimised or a condition where a large force/amount of energy is required, e.g. due to delamination/debonding of the fibres of the wood pulp, may be minimised.

As used herein the term "perforation region" may refer to a region that is directly abutted by the penetrator, e.g. a wetted area of/ area overlapped by a section in the longitudinal and lateral plane on the penetrator prior to penetration.

As used herein the term "comparatively easier" in respect of perforation by the penetrator may refer to one or more of: a perforation of the perforation region that comprises a more brittle type failure mode with comparatively lower energy absorption rather than a ductile type failure mode

with comparatively higher energy absorption of an untreated region; less displacement of the penetrator to achieve full penetration (e.g. due to a reduced thickness of the perforation region and/or less movement of the perforation region with the penetrator) and; a penetration with a lower maximum force.

In embodiments, the perforation region includes one or more of the following material properties compared to a portion that is not treated: reduced water absorbency; increased brittleness (e.g. characterised by a more brittle type fracture with low energy absorption); increased stiffness, and; reduced thickness.

As used herein the term "water absorption" may refer to an amount, e.g. in grammes, of water absorbed per unit area, e.g. in m² of the wood pulp based material for a given time, e.g. 60 or 180 seconds. Examples of suitable tests include Cobb60 or Cobb180 tests. By implementing a perforation region with reduced water absorption the perforation region may be easier to penetrated than if waterlogged since a waterlogged portion may expand thus requiring more displacement to fully penetrate and be more likely to displace with the penetrator rather than be penetrated.

In embodiments, the perforation region is treated by one or more of the following processes: pressing; heat treatment; applying a coating, and scoring.

As used herein the term "heat treatment" may refer to an application/extraction of thermal energy as part of the treatment process. Typically heat treatment includes increasing a temperature of the wood pulp-based material. In embodiments, the temperature may be 100 – 300 or 100 to 400 degrees C.

As used herein the term "pressing" may refer to the application of a compressive force in the through-thickness direction of the wood pulp-based material to reduce a thickness. In embodiments, the pressure may be 1×10^5 - 1×10^7 Pa or 1×10^4 - 1×10^8 Pa.

In embodiments, the heat treatment and/or pressing may be applied for 2 - 10 seconds.

As used herein the term "applying a coating" may refer to the application of a coating to the wood pulp-based material to close pores/interstices between the fibres and/or to act as a barrier. This may provide reduced water absorption, which may be advantageous for the reasons previously given. This may also provide a more brittle type failure, which may be advantageous for the

reasons previously given. The coating may comprise caramelised sugar or starch or other suitable coating.

In embodiments, the perforation region has a reduced thickness by at least 20% or 30% or 35% compared to a portion that is not treated. For example, a 0.5 mm thick material may have the thickness reduced to 0.3 mm thickness. In embodiments, a maximum thickness reduction may be 60 to 70%.

In embodiments, the perforation region is arranged at a base of a cavity of the storage portion.

In embodiments, the perforation region is arranged as an annular ring which is central about an axis of rotation of the container. An annular ring may be convenient to form by a shaped press. Moreover, it may be ensured that a penetrator composed of discrete penetration elements that are arranged about the axis of rotation of the container has an element always aligned with a portion annular ring.

In embodiments, the annular ring is arranged as segments, which are bounded by bridges that are not treated. By implementing bridges that bound the segments an overall strength of the base may be maintained since force between an inside of the annular ring can be transmitted principally via the bridges, rather than entirely through the brittle segments.

In embodiments, the bridges are arranged to have a different angular pitch compared to an angular pitch of penetration elements forming the penetrator of the machine. By implement the angular pitch to be different, even if one penetration element happens to be aligned to a bridge, others will not, hence it may be ensured that at least one penetration element entirely penetrates a segment of the perforation region rather than a bridge.

In embodiments, the perforation region is configured to be perforated by one or more penetrator elements with a total area of 6 – 15 mm² when subject to at least 2 - 10 Newtons or 0.5 – 50.

In embodiments, at least the base and/or the sidewall (or all) of the storage portion is formed of a wood pulp-based material. In embodiments, the wood pulp-based material has a thickness of 0.25 mm to 0.75 mm (e.g. for a region that is not treated).

In embodiments, at least part of the container is formed of a wood pulp-based material, wherein the wood pulp-based material includes a treatment region. In embodiments, the treatment region is treated to glassify the wood pulp-based material (e.g. by the application of pressure and heat as disclosed herein). In embodiments, the treatment region is located on a lower surface of a

flange portion of the container. The treatment region may enable a narrower flange than for an untreated wood pulp-based material, which is comparable in thickness to a flange formed of conventional materials (e.g. aluminium) of an conventional container. This may enable the container to be compatible with machines designed for conventional containers. The treatment region may also provide a more consistent (e.g. smoother with reduced discontinuities) surface to receive a code.

In embodiments, at least a base region of the storage portion is formed of a wood pulp-based material, wherein the storage portion includes stiffener portions, which are disposed to stiffen the storage portion (e.g. the base, or more particularly a perforation region of the base) to resist displacement (e.g. compared to an equivalent container without the stiffener portions) when the base is perforated by a penetrator of the machine.

By implementing stiffener portions in combination with wood pulp-based material for the base, it may be ensured that the wood pulp-based base is cleanly penetrated by a penetration of the machine when performing the container to form one or more fluid inlets for injection of conditioned fluid to form a beverage. It may also be ensured that the wood pulp-based base is not crushed by the penetrator during the fluid inlets formation.

As used herein the term "displacement" may refer to a depth (or other component of displacement) of the base when the penetrator is moved through the base in the depth direction. It will be understood that the base is required to resist displacement so that it does not displace/is minimally displaced locally by the penetrator such that it remains relatively undeformed as the penetrator is moved therethrough. It will also be understood that a perforation region is required to fracture/crack rather than displace.

As used herein the term "base" may refer to a portion of the container that forms the lowest surface of the cavity, and which closes sidewall. The base may have a lateral and longitudinal component (or a radial component) that is greater than a depth component.

As used herein the term "sidewall" may refer to a portion of the container that is arranged between the base and the flange portion. The sidewall may have a principal component in the depth direction.

As used herein the term "base region" may refer to a portion of the container that includes the base and a proximal portion of the sidewall adjoining the base. Proximal and distal are defined herein as relative the base. Hence a proximal portion refers to a portion of the sidewall in

immediate proximity to the base. The stiffener portions can be located on a portion of the sidewall that significantly effects the rigidity of the base. The base region may include a portion of the sidewall that has a distance d , which is measured from the lowest position of the base in the depth direction, that is less than 50% or 40% of the total depth D , which is measured from said lowest position of the base to a top of the flange portion.

As used herein the term "stiffener portion" may refer to a portion of the wood pulp-based material that is geometrically adapted from a regular shape of the container to provide increased stiffness of the base. The stiffness of the base may be determined based one or more of: a rigidity (e.g. a Youngs modulus) of the base region itself, including the stiffness of the base and/or the sidewall; a structural constraint at a joining of the base and sidewall that provides a more rigid support for the base. The stiffener portion may be formed from the same wood pulp-based material as the rest of the base region, including in composition and thickness.

As used herein the term "resist displacement" may refer to the base itself being stiffer so that it displaces, e.g. flexes, less when impacted by a penetrator. It may also refer to the sidewall being less likely to buckle (or otherwise displace) and therefore the base resisting displacement based of reduced buckling of the sidewall.

In embodiments, the stiffener portions are arranged to extend over both the base and the proximal region of the side wall. By arranging the stiffener portions to extend continuously over the base and side wall, they may provide enhanced stiffness increases.

In embodiments, the stiffener portions protrude into the interior of the storage portion and may not outwardly from the exterior. By implementing the stiffener portions so that their geometric formations are entirely formed within the container (e.g. no portion of the stiffener portion extends beyond the profile of the container (compared an equivalent portion of the container that does not include the stiffener portion), existing machines may be compatible with the new and inventive configuration of capsule.

In embodiments, the stiffener portions are arranged as channels that bridge the base and proximal region of the side wall. By arranging the channels to interconnect portions of the sidewall and base that are not interconnected compared an equivalent portion of the container that does not include the stiffener portion, the rigidity may be improved.

In embodiments, a base of the channels is linear. A linear base of the channel may provide improved buckling/displacement resistance. The channel may have a V-shaped, U-shaped or other suitably shaped section.

In embodiments, the channels are radially aligned. By implementing the channels to be radially aligned, such that the base of the channel extends with a combined lateral and longitudinal component aligned to the radial direction, improved buckling/displacement resistance may be provided.

In embodiments, the stiffener portions have a maximum channel depth X of less than 10 mm and greater than 2 mm or less than 8 mm and greater than 4 mm. The channel depth X may be defined as a perpendicular distance from a base of the channel to a virtual line for a section that does not comprise a stiffener portion. With such a range the channels may provide enhanced stiffness.

In embodiments, the stiffener portions are arranged to extend in a depth direction along the sidewall by a distance Y from the junction with the base (e.g. at a virtual location of the junction when measured for an equivalent portion of the container that does not comprise a stiffener portion) to a depth of less than 40% or 30% of the total depth D between the storage portion and base. Distance Y may be at least 5 or 10%. With such a range the stiffener portions may provide enhanced stiffness.

In embodiments, the stiffener portions are arranged to extend along the base from a periphery of the base to a radii Z of greater than 30% or 40% of the total radii R of the base. With such a range the stiffener portions may provide enhanced stiffness.

In embodiments, the stiffener portions are arranged to extend along the base from a periphery to contiguous a perforation region that is perforated by a penetrator of the machine. By arranging the stiffener portions to be highly proximal the perforation region, they may provide high structural support to a portion of the base that is perforated.

As used herein the term "contiguous" may refer to exactly adjoining or in close proximity (e.g. within 4 or 2 or 1 mm). As used herein the term "perforation region" may refer to a region that is directly abutted by the penetrator, e.g. a wetted area of/ area overlapped by a section in the longitudinal and lateral plane on the penetrator prior to penetration.

In embodiments, the stiffener portions are arranged to prevent a perforation region of the base displacing (e.g. an average displacement for the whole perforation region) by more than 0.5 – 2

mm in a depth direction, when the perforation region is subject to a compressive force in the depth direction of 1 – 50 N or 2 – 10 N, which is applied by the penetrator.

In embodiments, the stiffener portions comprise discrete units (e.g. that are separate from each other) that are circumferentially disposed about a circumference of the container. An undulating arrangement of equally spaced stiffener portions may provide increase stiffness.

In embodiments, the stiffener portions are arranged only on the base or on the sidewall.

In embodiments, the storage portion comprises the cavity with sidewall, a base and a flange portion to interconnect the storage portion and the closing member, wherein the sidewall comprise a shoulder proximal the base that extends outwardly (e.g. away from an interior of the cavity) to define a void defining region of the sidewall that is arranged between the shoulder and the base the shoulder, and the container holding portion.

By implementing a shoulder contiguous the stiffener portions and reducing locally the diameter of the container, the rigidity of the base is increased.

The shoulder may additionally form centering means during engagement of the container inside the container holding portion to have it precisely positioned inside the container holding portion.

As used herein the term “shoulder” may refer to a portion of the sidewall that projects in a longitudinal and/or lateral direction (e.g. outwardly in the radial direction) from a remainder of the sidewall as a step, chamfer or otherwise.

As used herein the term “proximal” in respect of a position of the shoulder and the base may refer to the shoulder being arranged to directly adjoin the base, or being in close proximity of e.g. within 1 or 2 mm in a depth direction.

As used herein the term “void region” may refer to a region of the sidewall that is arranged in use to be separate, i.e. distal, from the container holding portion.

In embodiments, the shoulder extends from the flange portion to a rim of the sidewall (e.g. a step or a chamfer or a curved or other shaped discontinuity in the outer surface profile). An entirety of the shoulder (e.g. in terms of depth and/or circumference) between the flange portion and rim of the side wall may engage the container holding portion. Such an arrangement may provide high stability in spite of the void.

In embodiments, the shoulder has a depth distance S between the flange portion and a rim of the sidewall of comprised between 50 and 80% of the total depth D of the storage portion, which may be measured from said lowest position of the base to a top of the flange portion. In embodiments, the shoulder has a depth distance S between the flange portion and rim of greater than 60% or 65% or 70% of the total depth D of the storage portion. By having the shoulder within such a % depth range, a sufficient level of stability may be provided in spite of the void. Additionally, the rigidity of the base portion is increased and thus the base may sustain increased pressure during perforation by the penetrator of the machine.

In embodiments, the void defining region of the sidewall extends in the depth direction and/or circumferential direction from the shoulder (e.g. including entirely) to the base of the container. By implementing the container (and positioning the shoulder proximate the base) so that no portion of the sidewall is in contact with the container holding portion, it may be ensured that the container is less likely to stick in the container holding portion.

In embodiments, the void defining region of the sidewall is arranged to have a separation distance N in a radial direction from the container holding portion of at least 0.5mm and/or less than 1.5cm. By ensuring a minimum separation of the void defining region and the sidewall of this amount the container may be less likely to stick in the container holding portion.

In embodiments, an average of the separation distances N between the void defining region of the sidewall and the container holding portion is at least 0.5 mm or 1 mm. By ensuring an average separation of the void defining region and the sidewall of this amount the container may be less likely to stick in the container holding portion.

The container is arranged to be stacked partially within a second corresponding in shape container. An edge of the container corresponding to the intersection of the sidewall and the base of the container engages the rim of the shoulder of the second container. Part of the void defining region of the sidewall of the container that is adjacent the shoulder of the second container is maintained. With such an arrangement, containers prior to filling may be stacked with reduced sticking.

In embodiments, the stiffener portions of any preceding embodiment or another embodiment disclosed herein is implemented in combination with the shoulder to stiffen the void defining region of the sidewall. By implementing the stiffener portions to stiffen the void defining region of the

sidewall, a reduced stability of the sidewall due to it not being in contact with the container holding portion, and therefore being stabilized by said portion, may be compensated for.

In embodiments, the stiffener portions protrude into an interior of the storage portion and not outwardly from an exterior thereof. By implementing the stiffener portions to protrude into an interior of the cavity of the storage portion, the void region may be maintained around the stiffener portions to reduce sticking. In embodiments, the stiffener portions are arranged as channels that bridge the base and the void defining region of the side wall. By arranging the stiffener portion to interconnect the void defining region of the side wall and the base, a stability of the void defining region may be increased.

Thanks to combination of two of more of the perforation region, the stiffener portions and the shoulder the rigidity of the base portion of the container is increased thereby improving the container's behavior during its extraction in the beverage preparation machine.

The present disclosure provides a system comprising a container of any preceding embodiment or another embodiment disclosed herein and a machine for preparing a beverage and/or foodstuff or a precursor thereof. In embodiments, the machine includes: a processing unit for processing the precursor material of the container, and electrical circuitry to control the processing unit.

The present disclosure provides, use of the container of any preceding embodiment or another embodiment disclosed herein for a machine as discussed herein.

The present disclosure provides a method of preparing a beverage and/or foodstuff or a precursor thereof. The method may be implemented with any preceding embodiment or another embodiment disclosed herein. The method comprises: perforating with a penetrator of said machine a perforation region, which is treated to facilitate comparatively easier perforation by the penetrator of the machine than a portion that is not treated, supplying conditioned fluid to precursor material of the container via the perforation and processing the precursor material.

In embodiments, processing the precursor material includes one or more of the following processes: injecting conditioned fluid into the container via inlets at the perforation region in a base of the container formed by the machine; increasing a pressure of fluid in the container until a rupturing portion of the container ruptures to provide the beverage, and ejecting a spend container from the container processing unit.

The present disclosure provides a method of forming a container for use with a machine for preparing a beverage and/or foodstuff or a precursor thereof. The method may be implemented with any preceding embodiment or another embodiment disclosed herein. The method comprises: processing a perforation region of the container that is formed of a wood pulp-based material to facilitate comparatively easier perforation by a penetrator of the machine than a portion that is not treated. In embodiments, the method comprises: forming a storage portion of the container, and subsequently; processing the storage portion to implement the perforation region.

The present disclosure provides a method of preparing a beverage and/or foodstuff or a precursor thereof. The method may be implemented with any preceding embodiment or another embodiment disclosed herein. The method comprises: penetrating a wood pulp-based portion of a container with a penetrator to provide fluid inlets and resisting displacement of the wood pulp based portion during said penetration with stiffener portions, and; processing the precursor material.

In embodiments, processing the precursor material includes one or more of the following processes: injecting conditioned fluid into the container via inlets at a perforation region in a base of the container formed by the machine; increasing a pressure of fluid in the container until a rupturing portion of the container ruptures to provide the beverage, and ejecting a spent container from the container processing unit.

The present disclosure provides a method of forming a container. The method may be implemented with any preceding embodiment, or another embodiment disclosed herein. The method comprises: forming a storage portion of the container from a wood pulp-based material, which may comprise wet forming, that may include hot pressing. The method may comprise forming the stiffening portions with the storage portion of subsequently.

The present disclosure provides a method of preparing a beverage and/or foodstuff or a precursor thereof. The method may be implemented with any preceding embodiment or another embodiment disclosed herein. The method comprises: arranging a container containing precursor material in a container holding portion of a processing unit of a machine; engaging a shoulder of a sidewall of the container that is profiled to maintain a void between a portion of the sidewall between a base and the shoulder, penetrating a wood pulp-based portion of a container with a penetrator to provide fluid inlets and resisting displacement of the wood pulp-based portion during said penetration with stiffener portions, transmitting fluid into the container via the fluid inlets, and processing the precursor material.

In embodiments, processing the precursor material includes one or more of the following processes: injecting conditioned fluid into the container via inlets at a perforation region in a base of the container formed by the machine; increasing a pressure of fluid in the container until a rupturing portion of the container ruptures to provide the beverage, and ejecting a spend container from the container processing unit. During one or all of said processes the void between the portion of the sidewall between a base and the shoulder and the container holding portion may be maintained.

The present disclosure provides a method of filling a container with precursor material. The method may be implemented with any preceding embodiment, or another embodiment disclosed herein. The method comprises: arranging the container in a container holding portion of a filling machine; engaging a shoulder of a sidewall of the container that is profiled to maintain a void between a portion of the sidewall between a base and the shoulder, and filling the container with the precursor material. The method may comprise ejecting a filled container from the filling machine. During one or all of said processes the void between the portion of the sidewall between a base and the shoulder and the container holding portion may be maintained.

The preceding summary is provided for purposes of summarizing some embodiments to provide a basic understanding of aspects of the subject matter described herein. Accordingly, the above-described features are merely examples and should not be construed to narrow the scope or spirit of the subject matter described herein in any way. Moreover, the above and/or proceeding embodiments may be combined in any suitable combination to provide further embodiments. Other features, aspects, and advantages of the subject matter described herein will become apparent from the following Detailed Description of Embodiments, Brief Description of Figures, and Claims.

BRIEF DESCRIPTION OF FIGURES

Aspects, features and advantages of embodiments of the present disclosure will become apparent from the following detailed description of embodiments in reference to the appended drawings in which like numerals denote like elements.

- Figure 1 is a block system diagram showing an embodiment system for preparation of a beverage or foodstuff or a precursor thereof.
- Figure 2 is a block system diagram showing an embodiment machine of the system of figure 1.

- Figure 3 is an illustrative diagram showing an embodiment fluid conditioning system of the machine of figure 2.
- Figures 4A and 4B are illustrative diagrams showing an embodiment container processing system of the machine of figure 2.
- Figure 5 is a block diagram showing embodiment control electrical circuitry of the machine of figure 2.
- Figure 6 is an illustrative diagram showing an embodiment container of the system of figure 1.
- Figure 7 is flow diagram showing an embodiment preparation process, which is performed by the system of figure 1.
- Figure 8 is a side view showing an embodiment storage portion of the container of figure 6.
- Figure 9 is a top view showing the storage portion of figure 8.
- Figure 10 is a side cross-sectional view showing the storage portion of figure 9 though section lines A-A.
- Figure 11 is a bottom perspective view showing the storage portion of figure 8.
- Figure 12 is a top perspective view showing the storage portion of figure 8.
- Figure 13 is a side cross-sectional view showing the cross-section of figure 10 with a superimposed cross-section without a stiffener portion shown as a virtual section line.
- Figure 14 is a side cross-sectional view showing the cross-section of the storage portion of figure 10 and cross-section of a container holding portion of the system of figure 1.
- Figure 15 is a side cross-sectional view showing a portion of the storage portion of figure 10 stacked with a corresponding container.
- Figure 16 is a top perspective view showing the storage portion of figure 8.

DETAILED DESCRIPTION OF EMBODIMENTS

Before describing several embodiments of the system, it is to be understood that the system is not limited to the details of construction or process steps set forth in the following description. It will be apparent to those skilled in the art having the benefit of the present disclosure that the system is capable of other embodiments and of being practiced or being carried out in various ways.

The present disclosure may be better understood in view of the following explanations:

As used herein, the term "**machine**" may refer to an electrically operated device that: can prepare, from a precursor material, a beverage and/or foodstuff, or; can prepare, from a pre-precursor material, a precursor material that can be subsequently prepared into a beverage and/or foodstuff. The machine may implement said preparation by one or more of the following processes: dilution; heating; pressurisation; cooling; mixing; whisking; dissolution; soaking; steeping; extraction; conditioning; infusion; grinding, and other like process. The machine may be dimensioned for use on a work top, e.g. it may be less than 70 cm in length, width and height. As used herein, the term "**prepare**" in respect of a beverage and/or foodstuff may refer to the preparation of at least part of the beverage and/or foodstuff (e.g. a beverage is prepared by said machine in its entirety or part prepared to which the end-user may manually add extra fluid prior to consumption, including milk and/or water).

As used herein, the term "**container**" may refer to any configuration to contain the precursor material, e.g. as a single-serving, pre-portioned amount. The container may have a maximum capacity such that it can only contain a single-serving of precursor material. The container may be single use, e.g. it is physically altered after a preparation process, which can include one or more of: perforation to supply fluid to the precursor material; perforation to supply the beverage/foodstuff from the container; opening by a user to extract the precursor material. The container may be configured for operation with a container processing unit of the machine, e.g. it may include a flange for alignment and directing the container through or arrangement on said unit. The container may include a rupturing portion, which is arranged to rupture when subject to a particular pressure to deliver the beverage/foodstuff. The container may have a membrane for closing the container. The container may have various forms, including one or more of: frustoconical; cylindrical; disk; hemispherical, and other like form. The container may be formed from various materials, such as metal or plastic or wood pulp based a combination thereof. The material may be selected such that it is: food-safe; it can withstand the pressure and/or temperature of a preparation process. The container may be defined as a capsule, wherein a capsule may have an internal volume of 20 - 100 ml. The capsule includes a coffee capsule, e.g. a Nespresso® capsule (including a Classic, Professional, Vertuo, Dolce Gusto or other capsule).

As used herein, the term "**external device**" or "**external electronic device**" or "**peripheral device**" may include electronic components external to the machine, e.g. those arranged at a same location as the machine or those remote from the machine, which communicate with the machine over a computer network. The external device may comprise a communication interface for communication with the machine and/or a server system. The external device may comprise

devices including: a smartphone; a PDA; a video game controller; a tablet; a laptop; or other like device.

As used herein, the term "**server system**" may refer to electronic components external to the machine, e.g. those arranged at a remote location from the machine, which communicate with the machine over a computer network. The server system may comprise a communication interface for communication with the machine and/or the external device. The server system can include: a networked-based computer (e.g. a remote server); a cloud-based computer; any other server system.

As used herein, the term "**system**" or "**beverage or foodstuff preparation system**" may refer to the combination of any two or more of: the beverage or foodstuff preparation machine; the container; the server system, and the peripheral device.

As used herein, the term "**beverage**" may refer to any substance capable of being processed to a potable substance, which may be chilled or hot. The beverage may be one or more of: a solid; a liquid; a gel; a paste. The beverage may include one or a combination of: tea; coffee; hot chocolate; milk; cordial; vitamin composition; herbal tea/infusion; infused/flavoured water, and other substance. As used herein, the term "**foodstuff**" may refer to any substance capable of being processed to a nutriment for eating, which may be chilled or hot. The foodstuff may be one or more of: a solid; a liquid; a gel; a paste. The foodstuff may include yoghurt; mousse; parfait; soup; ice cream; sorbet; custard; smoothies; other substance. It will be appreciated that there is a degree of overlap between the definitions of a beverage and foodstuff, e.g. a beverage can also be a foodstuff and thus a machine that is said to prepare a beverage or foodstuff does not preclude the preparation of both.

As used herein, the term "**precursor material**" may refer to any material capable of being processed to form part or all of the beverage or foodstuff. The precursor material can be one or more of a: powder; crystalline; liquid; gel; solid, and other. Examples of a beverage forming precursor material include ground coffee; milk powder; tea leaves; coco powder; vitamin composition; herbs, e.g. for forming a herbal/infusion tea; a flavouring, and; other like material. Examples of a foodstuff forming precursor material include dried vegetables or stock as anhydrous soup powder; powdered milk; flour-based powders including custard; powdered yoghurt or ice-cream, and; other like material. A precursor material may also refer to any pre-precursor material capable of being processed to a precursor material as defined above, i.e. any precursor material that can subsequently be processed to a beverage and/or foodstuff. In an

example, the pre-precursor material includes coffee beans which can be ground and/or heated (e.g. roasted) to the precursor material.

As used herein, the term "**fluid**" (in respect of fluid supplied by a fluid conditioning system) may include one or more of: water; milk; other. As used herein, the term "**conditioning**" in respect of a fluid may refer to changing a physical property thereof and can include one or more of the following: heating or cooling; agitation (including frothing via whipping to introduce bubbles and mixing to introduce turbulence); portioning to a single-serving amount suitable for use with a single serving container; pressurisation e.g. to a brewing pressure; carbonating; filtering/purifying, and; other conditioning process.

As used herein, the term "**processing unit**" may refer to an arrangement that can process precursor material to a beverage or foodstuff. It may refer to an arrangement that can process a pre-precursor material to a precursor material.

As used herein, the term "**container processing unit**" may refer to an arrangement that can process a container to derive an associated beverage or foodstuff from a precursor material. The container processing unit may be arranged to process the precursor material by one of more of the following: dilution; heating; cooling; mixing; whisking; dissolution; soaking; steeping; extraction; conditioning; pressurisation; infusion, and; other processing step. The container processing unit may therefore implement a range of units depending on the processing step, which can include: an extraction unit (which may implement a pressurised and/or a thermal, e.g. heating or cooling, brewing process); a mixing unit (which mixes a beverage or foodstuff in a receptacle for end user consumption therefore); a dispensing and dissolution unit (which extracts a portion of the precursor material and processes by dissolution and dispenses it into a receptacle), and; other like unit.

As used herein, the term "**preparation process**" may refer to a process to prepare a beverage or foodstuff from a precursor material or to prepare a pre-precursor material from precursor material. A preparation process may refer to the processes electrical circuitry executes to control the container processing unit to process said precursor or pre-precursor material.

As used herein, the term "**electrical circuitry**" or "**circuitry**" or "**control electrical circuitry**" may refer to one or more hardware and/or software components, examples of which may include: an application specific integrated circuit (ASIC); electronic/electrical componentry (which may include combinations of transistors, resistors, capacitors, inductors etc); one or more processors;

a non-transitory memory (e.g. implemented by one or more memory devices), that may store one or more software or firmware programs; a combinational logic circuit; interconnection of the aforesaid. The electrical circuitry may be located entirely at the machine or distributed between one or more of: the machine; external devices; a server system.

As used herein, the term "**processor**" or "**processing resource**" may refer to one or more units for processing, examples of which include an ASIC, microcontroller, FPGA, microprocessor, digital signal processor (DSP), state machine or other suitable component. A processor may be configured to execute a computer program, e.g. which may take the form of machine readable instructions, which may be stored on a non-transitory memory and/or programmable logic. The processor may have various arrangements corresponding to those discussed for the circuitry, e.g. on-board machine or distributed as part of the system. As used herein, any machine executable instructions, or computer readable media, may be configured to cause a disclosed method to be carried out, e.g. by the machine or system as disclosed herein, and may therefore be used synonymously with the term method.

As used herein, the term "**code**" or "**code element**" may refer to storage medium that encodes preparation information. The code may be an optically readable code, e.g. a bar code. The code may be formed of a plurality of units, which can be referred to as elements or markers.

As used herein, the term "**preparation information**" may refer to information related to a preparation process. Depending on the implementation of the processing unit said information may vary. The parameters that may be associated container processing unit that comprises a fluid processing system, can include one or more of: fluid pressure; fluid temperature; mass/volumetric flow rate; fluid volume; filtering/purification parameters for the fluid, and; carbonation parameters for the fluid. More general parameters can include one or more of: container geometric parameters, e.g. shape or volume, and; the type of precursor.

As used herein the term "**wood pulp-based**" may refer to the material or a portion of material forming the container which is one or more of: porous; fibrous; cellulosic; formed of cellulosic material; formed of natural cellulosic material; formed of reconstituted or regenerated cellulosic material; non-woven; is composed entirely of or is a composition of wood pulp, and is wet formed. A thickness of the wood-based material may be 0.25 mm to 0.75 mm or about 0.5 mm. The wood-based material may be 200-400 gsm.

As used herein the term “**non-woven**” may refer to a fabric-like material which is not woven or knitted. A non-woven material may be made from bonded together fibres. As used herein the term “**porous**” may refer to material configured with interstices to transmit water (or other liquid) therethrough. As used herein the term “**fibrous**” may refer to material comprised of fibres, which may be present in one or more of the material constituents. As used herein the term “**cellulosic**” or “**cellulosic material**” may refer to conventionally woody and/or non-woody materials, e. g. manila hemp, sisal, jute, bleached and unbleached soft wood and hard wood species. A cellulosic material may include a regenerated or reconstituted cellulose. As used herein the term “**natural cellulosic material**” may refer to conventionally woody materials, which are not regenerated. As used herein the term “**reconstituted or regenerated cellulosic material**” may refer natural cellulosic material subject to processing that comprises reconstitution or regeneration, examples include rayon and lyocell. As used herein the term “**wood pulp**” may refer to a lignocellulosic fibrous material, which may be prepared by mechanical or chemical separation of cellulose fibres from one or more of wood, fibre crops, paper or rags. As used herein the term “**wet formed**” may refer to a process of forming from an aqueous solution of fibres. The aqueous solution of fibres may be heated and pressed in a mould to set the material and remove water therefrom.

[General system description]

Referring to figure 1, the system **2** comprises a machine **4**, a container **6**, server system **8** and a peripheral device **10**. The server system **8** is in communication with the machine **4** via a computer network **12**. The peripheral device **10** is in communication with the machine **4** via the computer network **12**.

In variant embodiments, which are not illustrated: the peripheral device and/or server system is omitted.

Although the computer network **12** is illustrated as the same between the machine **4**, server system **8** and peripheral device **10**, other configurations are possible, including: a different computer network for intercommunication between each device: the server system communicates with the machine via the peripheral device rather than directly. In a particular example: the peripheral device communicates with the machine via a communication interface, e.g. with a Bluetooth™ protocol, and; the server system communicates with the machine via a via a wireless interface, e.g. with a IEE 802.11 standard, and also via the internet.

[Machine]

Referring to figure 2, the machine **4** comprises: a processing unit **14** for processing the precursor material; electrical circuitry **16**, and; a code reading system **18**.

The electrical circuitry **16** controls the code reading system **18** to read a code (not illustrated in figure 2) from the container **6** and determine preparation information therefrom. The electrical circuitry **16** uses the preparation information to control the processing unit **14** to execute a preparation process, in which the precursor material is process to a beverage or foodstuff or a precursor thereof.

In variant embodiments, which are not illustrated: the code and code reading system is omitted and the machine executes one or more preparation processes stored on an electronic memory of the electrical circuitry.

[First example of Processing unit]

Referring to figures 3 and 4, in a first example of the processing unit **14**, said unit comprises a container processing unit **20** and a fluid conditioning system **22**.

The container processing unit **20** is arranged to process the container **6** to derive a beverage or foodstuff from precursor material (not illustrated) therein. The fluid conditioning system **22** conditions fluid supplied to the container processing unit **20**. The electrical circuitry **16** uses the preparation information read from the container **6** to control the container processing unit **20** and the fluid conditioning system **22** to execute the preparation process.

The code reading system **18** of the machine may comprise an image capturing unit **46** to detect and/or read a code element **44** positioned on the capsule for processing specific recipes and propose optimised extraction of the ingredient contained in the capsule.

[Fluid conditioning system]

Referring to figure 3, the fluid conditioning system **22** includes a reservoir **24**; pump **26**; heat exchanger **28**, and an outlet **30** for the conditioned fluid. The reservoir **24** contains fluid, typically sufficient for multiple preparation processes. The pump **26** displaces fluid from the reservoir **24**, through the heat exchanger **28** and to the outlet **30** (which is connected to the container processing unit **20**). The pump **26** can be implement as any suitable device to drive fluid, including: a reciprocating; a rotary pump; other suitable arrangement. The heat exchanger **28** is

implemented to heat the fluid, and can include: an in-line, thermo block type heater; a heating element to heat the fluid directly in the reservoir; other suitable arrangement.

In variant embodiments, which are not illustrated: the pump is omitted, e.g. the fluid is fed by gravity to the container processing unit or is pressurised by a mains water supply; the reservoir is omitted, e.g. water is supplied by a mains water supply; the heat exchanger is arranged to cool the fluid, e.g. it may include a refrigeration-type cycle heat pump); the heat exchanger is omitted, e.g. a mains water supply supplies the water at the desired temperature; the fluid conditioning system includes a filtering/purification system, e.g. a UV light system, a degree of which that is applied to the fluid is controllable; a carbonation system that controls a degree to which the fluid is carbonated.

[Container processing unit]

The container processing unit **20** can be implemented with a range of configurations, as illustrated in examples 1 – 4 below:

Referring to figures 4A and 4B, a first example of the container processing unit **20** is for processing of a container arranged as a capsule **6** (a suitable example of a capsule is provided in figure 6, which will be discussed) to prepare a beverage. The container processing unit **20** is configured as an extraction unit **32** to extract the beverage from the capsule **6**. The extraction unit **32** includes a container/capsule holding portion **34** and a closing member **36**. The extraction unit **32** is movable to a capsule receiving position (figure 4A), in which the capsule holding portion **34** and the closing member **36** are arranged to receive a capsule **6**. The extraction unit **32** is movable to a capsule extraction position (figure 4B), in which the capsule holding portion **34** and a closing member **36** form a seal around a capsule **6**. As shown in figure 4A, the image capturing unit **46** provided on the closing member is arranged to read a code element **44** positioned on the capsule when the capsule is in the extraction position (figure 4B).

The beverage can then be extracted from the capsule **6**. The extraction unit **32** can be actuator driven or manually movable between said positions.

The outlet **30** of the fluid conditioning system **22** is arranged as an injection head and/or penetrator **38** to penetrate the container to form inlets for injection of the conditioned fluid into the capsule **6** in the capsule extraction position, typically under high pressure. A beverage outlet **40** is arranged to capture the extracted beverage and convey it from the extraction unit **32**.

The extraction unit **32** is arranged to prepare a beverage by the application of pressurised (e.g. at 10 – 20 Bar), heated (e.g. at 50 – 98 degrees C) fluid to the precursor material within the capsule **6**. The pressure is increased over a predetermined amount of time until a pressure of a rupturing portion, which is the closing member of the capsule **6** is exceeded, which causes rupture of said member and the beverage to be dispensed to the beverage outlet **40**.

In variant embodiments, which are not illustrated, although the injection head and beverage outlet are illustrated as arranged respectively on the holding portion and closing member, they may be alternatively arranged, including: the injection head and beverage outlet are arranged respectively on the closing member and holding portion; or both on the same portion. Moreover, the extraction unit may include both parts arranged as a capsule holding portion, e.g. for capsules that are symmetrical about the flange, including a Nespresso® Professional capsule.

Examples of suitable extraction units are provided in EP 1472156 A1 and in EP 1784344 A1, which are incorporated herein by reference, and provide a hydraulically sealed extraction unit.

In a second example (which is not illustrated) of the container processing unit a similar extraction unit to the first example is provided, however the extraction unit operates at a lower pressure and by centrifugation. An example of a suitable capsule is a Nespresso® Vertuo capsule. A suitable example is provided in EP 2594171 A1, which is incorporated herein by reference.

In a third example, (which is not illustrated) the capsule processing unit operates by dissolution of a beverage precursor that is selected to dissolve under high pressure and temperature fluid. The arrangement is similar to the extraction unit of the first and second example, however the pressure is lower and therefore a sealed extraction unit is not required. In particular, fluid can be injected into a lid of the capsule and a rupturing portion is located in a base of a storage portion of the capsule. An example of a suitable capsule is a Nespresso® Dolce Gusto capsule. Examples of suitable extraction units are disclosed in EP 1472156 A1 and in EP 1784344 A1, which are incorporated herein by reference.

In a fourth example, (which is not illustrated) the container processing unit is arranged as a mixing unit to prepare a beverage or foodstuff precursor that is stored in a container that is a receptacle, which is for end user consumption therefrom. The mixing unit comprises an agitator (e.g. planetary mixer or a spiral mixer or a vertical cut mixer) to mix and a heat exchanger to heat/cool the beverage or foodstuff precursor in the receptacle. A fluid supply system may also supply fluid

to the receptacle. An example of such an arrangement is provided in WO 2014067987 A1, which is incorporated herein by reference.

[Control electrical circuitry]

Referring to figure 5, the electrical circuitry **16** is implemented as control electrical circuitry **48** to control the processing unit **14** to execute a preparation process. In the embodiment of figure 5, for illustrative purposes, the processing unit **14** is exemplified as the first example, which comprises a container processing unit **20** and a fluid supply unit **22**.

The electrical circuitry **16**, **48** at least partially implements (e.g. in combination with hardware) an: input unit **50** to receive an input from a user confirming that the machine **4** is to execute a preparation process; a processor **52** to receive the input from the input unit **46** and to provide a control output to the processing unit **14**, and; a feedback system **54** to provide feedback from the processing unit **14** during the preparation process, which may be used to control the preparation process.

The input unit **50** is implemented as a user interface, which can include one or more of: buttons, e.g. a joystick button or press button; joystick; LEDs; graphic or character LCDs; graphical screen with touch sensing and/or screen edge buttons; other like device; a sensor to determine whether a container has been supplied to the machine by a user.

The feedback system **54** can implement one or more of the following or other feedback control-based operations:

- a flow sensor to determine a flow rate/volume of the fluid to the outlet **30** (shown in figure 3) of the fluid supply system **22**, which may be used to meter the correct amount of fluid to the container **6** and thus regulate the power to the pump **26**;
- a temperature sensor to determine a temperature of the fluid to the outlet **30** of the fluid supply unit **22**, which may be used to ensure the temperature of fluid to the container **6** is correct and thus regulate the power to the heat exchanger **28**;
- a level sensor to determine a level of fluid in the reservoir **24** as being sufficient for a preparation process;
- a position sensor to determine a position of the extraction unit **32** (e.g. a capsule extraction position or a capsule receiving position).

It will be understood that the electrical circuitry **16**, **48** is suitably adapted for the other examples of the processing unit **14**, e.g.: for the second example of the container processing system the feedback system may be used to control speed of rotation of the capsule.

[Container]

Referring to figure 6, a container **6**, that is for use with the first example of the processing unit **14** comprises the container **6** arranged as a capsule **6**. The capsule **6** includes: a closing member **56**; a storage portion **58**, and; a flange portion **60**.

A local container coordinate axis includes a depth direction **100**, longitudinal direction **102**, and a lateral direction **104**. A rotational axis **106** extends in the depth direction **100** and defines a radial direction **108**, which is in a plane defined by the longitudinal direction **102**, and the lateral direction **104**.

The capsule **6** has a circular cross-section when viewed in the plane defined by the longitudinal direction **102**, and the lateral direction **104**.

The closing member **56** is arranged in the plane defined by the longitudinal direction **102**, and the lateral direction **104**. The closing member **56** closes the storage portion **58** and comprises a flexible membrane. The closing member **56** has an exterior surface **62** that faces away from the storage portion **58** and an interior surface **64** that faces towards the storage portion **58**.

The flange portion **60** is arranged to interconnect the storage portion **58** and closing member **56** to hermetically seal the precursor material. The flange portion **60** is arranged as an annular ring, which extends in the radial direction **108** from an interior edge **66** to an exterior edge **68**. The flange portion **60** presents an upper surface **70**, which is arranged in the plane defined by the longitudinal direction **102**, and the lateral direction **104**. The upper surface **70** is connected by an adhesive to a periphery of the interior surface **64** of the closing member **56**. A lower surface **72** of the flange faces towards the storage portion **58**.

The storage portion **58** includes a cavity **74** for storage of the precursor material (not illustrated). The cavity **74** includes a sidewall **76** and a base **78**. The sidewall **76** extends principally in the depth direction **100** from a proximal edge **80** to a distal edge **82**, wherein proximal and distal are defined relative the base **78**. The sidewall **76** tapers with an increasing radial dimension from the proximal edge **80** to the distal edge **82**. The base **78** extends principally in the radial direction **108**, but also has a lesser component in the depth direction **100**. The base **78** extends from the axis

106 to a peripheral edge **84** that adjoins the proximal edge **80** of the sidewall **76**. The distal edge **82** of the sidewall **76** adjoins the interior edge **66** of the flange portion **60**. The storage portion **58** and flange portion **60** are integrally formed.

The capsule **6** has a diameter of 2 - 5 cm and an axial length of 2 - 4 cm. Constructional, manufacturing and/or (beverage) extraction details of containers and/or closing members are for instance disclosed in EP 2155021, EP 2316310, EP 2152608, EP2378932, EP2470053, EP2509473, EP2667757 and EP 2528485.

In variant embodiments, which are not illustrated: the capsule may have other cross-section shapes, including square, other polygons, or elliptical; the closing member may be rigid or other non-membrane formation; the flange is alternatively connected to the upper surface of the closing member, e.g. by crimping; the sidewall is alternatively arranged, including with the reverse taper or is aligned to the depth direction, or is curved; the base is alternatively arranged, including with as flat or curved; the flange portion is connected to the storage portion rather than being integrally formed; the closing member is arranged as a storage portion, e.g. it comprises a cavity, and; the flange portion is omitted, e.g. the closing member connects directly to the storage portion.

Referring to figure 4A and 4B, the base **78** of the storage portion **58** is perforated by a penetrator **38** to form inlets for injection of conditioned fluid into the cavity **74** as will be discussed. The penetrator **38** may be arranged as separate blades or a blade that integrates the injector.

[Preparation Process]

Referring to figure 7, the execution of a process for preparing a beverage/foodstuff from precursor material is illustrated:

Block 70: a user supplies a container **6** to the machine **4**.

Block 72: the electrical circuitry **16** (e.g. the input unit **50** thereof) receives a user instruction to prepare a beverage/foodstuff from precursor, and the electrical circuitry **16** (e.g. the processor **52**) initiates the process.

Block 74: the electrical circuitry **16** controls the processing unit **14** to process the container (e.g. in the first example of the container processing unit **20**, the extraction unit **32** is moved from the capsule receiving position (figure 4A) to the capsule extraction position (figure 4B)).

Block 76: the electrical circuitry **16**, based on preparation information either read from a code on the container or stored on a memory, executes the preparation process by controlling the processing unit **14**. In the first example of the processing unit this comprises: controlling the fluid conditioning system **22** to supply fluid at a temperature, pressure, and time duration specified in the preparation information to the container processing unit **20**.

The electrical circuitry **16** subsequently controls the container processing unit **20** to move from the capsule extraction portion through the capsule ejection position to eject the container **6** and back to the capsule receiving position.

In variant embodiments, which are not illustrated: the above blocks can be executed in a different order, e.g. **block 72** before **block 70**; some block can be omitted, e.g. where a machine stores a magazine of capsules **block 70** can be omitted.

As part of the preparation process, the electrical circuitry **16** can obtain additional preparation information via the computer network **12** from the server system **8** and/or peripheral device **10** using a communication interface (not illustrated) of the machine.

[Container Stiffener Portions]

Referring to figures 8 to 13, the containers **6** associated with two possible containers embodiments of figure 6 are described as a single container for the common references. Hence the container **6** includes the storage portion **58** formed of a wood pulp-based material. In variant embodiments, which are not illustrated, only part of the storage portion may be formed of the wood pulp-based material, e.g. only the base or a base region as defined herein.

The storage portion **58** includes stiffener portions **110**, which are disposed to stiffen the storage portion **58**. In particular, the stiffener portions **110** stiffen proximal a perforation region **112** of the storage portion **58** that is penetrated by the penetrator **38** (shown in figure 4A and 4B) so that the perforation region **112** may be more easily penetrated.

The perforation region **112** once penetrated provides one or more fluid inlets (not illustrated) for injection of conditioned fluid into the cavity **74** of the storage portion **58** for processing the precursor material. Conditioned fluid is injected into the container holding portion **34** (shown in figure 4A and 4B), which is fluidically connected to said fluid inlets. The perforation region **112** is arranged on the base **78** of the storage portion **58** as an annular ring, which is centred about the axis of rotation **106**.

The penetrator (not shown) comprises three perforation elements, which are circumferentially disposed at equal angular pitches about around the annular ring of the perforation region **112**. Each of the perforation elements is arranged to form a dedicated inlet. A perforation element has a cross-sectional area of 2 – 5 mm². The penetrator applies a combined force (i.e. through all of the perforation elements summed together) of 1 – 50 N or 2 – 10 N in the counter depth direction **100** into the perforation region **112**. The perforation region **112** can be perforated by various failure modes including incision and/or brittle fracture, as will be discussed.

The stiffener portions **110** prevent the perforation region **112** of the base **78** displacing by more than 0.5 - 2 mm in the counter depth direction **100**, when the perforation region **112** is subject to a compressive force in said counter depth direction **100** of 1 – 50 N or 2 – 10 N, which is applied by the penetrator.

The size and dimension of the perforation region **112** may vary depending on the size and/or design of the container and/or of the perforation element of the beverage machine's penetrator to ensure full and efficient perforation.

In variant embodiments, which are not illustrated: the penetrator comprises other numbers of perforation elements, e.g. 1, 2 or 4; the perforation elements have a different cross-sectional area, e.g. the same total cross-sectional area as in the example may be distributed across the number of perforation elements; the penetrator applies a different force; the perforation region is arranged with a shape other than an annular ring, including as a circle or square.

The stiffener portions **110** are arranged as eight discrete units, which are circumferentially spaced apart from each other about the axis **106** with an equal angular pitch. The stiffener portions **110** extend continuously over both the base **78** and a proximal portion of the side wall **76**.

As can be best seen in figures 9 to 11 and 13, the stiffener portions **110** are arranged as channels **114** that have a sidewall **116** and a base **118**. The base **118** is linear and radially aligned. The sidewall **116** curve into the base **118**, hence the channels **114** are generally V-shaped with curved peripheries.

The channels **114** extend principally in the depth direction **100** and with a radial direction **108** component so that the base **118** is angled at an angle α of about 50 - 60 degrees to a plane defined by the longitudinal direction **102** and the lateral direction **104** (as best seen in the cross-section of figure 10A or 10B, when observing the right stiffener portion side).

As can be best seen in figure 10, the proximal end of the sidewall **76** has a depth dimension **d**, which is measured from a lowest position of the base **78** to a distal end of a base **118** of the stiffener portion **110**, that is less than about 40% of the total depth **D**, which is measured from said lowest position of the base **78** to the upper surface **70** of the flange portion **60**.

As can be best seen in figures 10 and 13, the stiffener portions **110** protrude in the counter radial direction **108** in to an interior of the cavity **74**, and no portion of the stiffener portion **110** has a greater radial dimension than a corresponding portion of the sidewall **76** that does not comprise a stiffener portion **110** (as best seen in the cross-section of figure 13, when comparing the stiffener portion **110** to the virtual section line **V** of an equivalent section without a stiffener portion). In this way the container **6** can be used with a container holding portion **34** that is not specifically adapted to hold the container **6** (e.g. by implementing grooves to contain an outwardly extending portion of a stiffener portion).

In variant embodiments, which are not illustrated: there are other numbers of stiffener portions, including 3, 4 or 6; the stiffener portions may directly adjoin each other; the stiffener portions have other profiles including U or V-shaped; the stiffener portions extend outwardly in the radial direction; the stiffener portions may be alternatively arranged, including with a curved or stepped base and a base which is not radially aligned; the base may be alternatively angled including an angle α of about 30 - 70 degrees, and; **d**, is alternatively dimensioned to be less than about 50% or 30% of **D** and/or **d** may have a minimum of at least 10 or 20% **D**.

Referring to figure 13, the stiffener portions **110** extend along the base **78** from a virtual peripheral edge **84'** of the base **78** (which is present for a section that does not comprise a stiffener portion as indicated by the virtual line **V**) to proximal the perforation region **112**. As best seen in figure 9, a distance **W** defined by a distal end of the base **118** of the channel **114** is within 4 mm in the radial direction **108** of the proximal most edge of the perforation region **112**. The distance **W** may vary depending on the size and dimension of the perforation region **112**.

As best seen in figure 13, the stiffener portions **110** have a maximum channel depth **X** of about 3 mm. The channel depth **X** is measured from perpendicular the base **118** to an intersection of the virtual section line **V** that does not comprise a stiffener portion. In the example the intersection between the perpendicular distance and virtual section line **V** occurs at the virtual proximal edge **80'** of the sidewall **76**. In variant embodiments, which are not illustrated: the depth **X** can be alternatively dimensioned, including 5 mm – 2 mm or 10 mm – 2 mm; the greatest depth may be at a position other than the proximal edge.

As best seen in figures 13, the stiffener portions **110** extend along the sidewall **76** in the counter depth direction **100** by a distance **Y**, which is determined as from a virtual proximal edge **80'** of the sidewall **76** for the virtual section line **V** to a distal end of the channel **114**. Distance **Y** is less than 40% or 30% of the total depth **D**. A minimum distance of **Y** may be greater than 10% or 20% of the total depth **D**.

The stiffener portions **110** extend along the base **78** in the counter radial direction **108** from the virtual peripheral edge **84'** of the base **78** for the virtual section line **V** to a radii **Z**. Radii **Z** is greater than 30% or 40% of the total radii **R** of the base. A maximum radius for **Z** may 90 or 80% of radii **R**.

As best seen in the cross-section of figure 13, when comparing the right stiffener portion **110** side to virtual line **V**, the stiffener portions **110** bridge the base **78** and a proximal region of the sidewall **76** that would otherwise not be bridged.

In variant embodiments, which are not illustrated: the stiffener portions are alternatively formed including as portions of increased material thickness e.g. a rib as opposed to a channel that extends into the interior of the cavity, and; the channel may include regions of increased material thickness including at the base.

At **block 74**, as shown in figure 7, the previously described preparation process can be implemented by: arranging the container **6** in the container holding portion **34** of the processing unit **14** of a machine **2**. The container **6** can be penetrated by the penetrator **38** to form inlets whilst stiffening the container **6** to resist displacement with the stiffener portions **110**.

A method of forming the storage portion can include wet forming the storage portion and stiffener portions concurrently, e.g. via the same mould/press. Alternatively, the stiffener elements may be subsequently pressed into the storage portion.

[Container Shoulder]

Referring to figures 8, 11 and 14, the sidewall **76** comprise a shoulder **120**, which is arranged to adjoin the stiffener portions **110**. The shoulder **120** extends in the depth direction **100** from the lower surface **72** of the flange portion **60** to a rim **122**. The shoulder **120** defines a linear outer surface **124** between the flange portion **60** and rim **122**. The outer surface **124** tapers with decreasing radial extent from the flange portion **60** to the rim **122**. Said tapering may facilitate

more convenient location of the container **6** in the container holding portion **34**. The rim **122** is curved.

Thanks to the location the shoulder **120**, i.e. proximal and adjacent the stiffener portions **110**, the radii **Z** of the base **78** is decreased in comparison to a container having a shoulder located proximal the flange portion **60** (not represented). This combination of both the shoulder **120** and adjacent stiffener portions **110** increases the rigidity of the container **6** at the base **78** and perforation region **112**. This is participating in ensuring efficient perforation of the container by the penetrator **38** of the beverage machine.

In variant embodiment, which are not illustrated: the shoulder is separated from the flange portion by a gap; the outer surface is alternatively profiled, including as curved or is aligned in the depth direction, and the rim is alternatively profiled, including as a step or linear ramp.

The outer surface **124** has a greater radial extent than a void defining region **126** of the sidewall **76**. The void defining region **126** of the sidewall **76** extends for the remainder of the sidewall **76** from the shoulder **120** to the base **78**.

In variant embodiment, which are not illustrated: an upper portion of the sidewall includes a second shoulder that engages with the container holding portion. This second shoulder may be positioned proximal the flange portion.

Referring to figure 14, the shoulder **120** is arranged to define with the container holding portion **34** of the processing unit **14** of the machine **2** the void defining region **126** and is positioned separated in the radial direction **108** from the container holding portion **34** to define a void **128** therebetween.

In the proposed embodiment, the shoulder **120** does not engage the container holding portion **34** thereby ensuring for reduced sticking of the container **6** in the container holding portion **34** (once the container has been extracted and needs to be removed from the container holding portion).

The shoulder **120** has a depth distance **S** between the lower surface **72** of the flange portion **60** and an intersection of the rim **122**, corresponding to the outer distance **124**. The outer surface **124** is between 50 and 80% of the total depth **D** of the storage portion **58** (as defined previously).

The void region **128** has a separation distance **N** in the radial direction **108**, between the void defining region **126** of the sidewall **76** and a directly adjacent portion of the container holding portion **34**, of an increasing distance from approximately 1 mm or 2 mm to approximately 1.5 cm.

Referring to figure 15, the container 6 is arranged to be stacked partially within a second, corresponding in shape, container 6'. The proximal edge 80 (being the intersection of the sidewall 76 and the base 78) of the container 6 engages the rim 122' of the shoulder 120' of the container 6'. A part of the void defining region 126 of the sidewall 76 of the container 6 that is adjacent the shoulder 120' of the second container 6', defining a remaining void 130' is maintained. With such an arrangement, containers prior to filling may be stacked with reduced sticking.

At **block 74**, as shown in figure 7, the previously described preparation process can be implemented by: arranging the container 6 in the container holding portion 34 of the processing unit 14 of a machine 2, and engaging the flange portion 60 of the container 6 with the container holding portion 34 to position the void defining region 126 of the sidewall 76 away from the container holding portion 34 to define the void region 128.

The container 6 can be penetrated by the penetrator 38 to form inlets and conditioned fluid injected into said inlets whilst the void region 128 is maintained. The container 6 can be ejected from the container holding portion 34 whilst the void region 128 is maintained.

A method of filling the container 6 with precursor material (not shown) comprises: arranging the storage portion 58 of the container 6 in a container holding portion (not shown, although it can be envisaged as being similar to the container holding portion 34 of the machine 2) of a filling machine (also not shown). This step can therefore be implemented as discussed for the container holding portion 34. The storage portion 58 may be supplied to the filling machine with two or more containers stacked in the previously described arrangement. After filling the storage portion 58 can be closed with the closing member 56.

A method of forming the storage portion can include wet forming the storage portion and shoulder concurrently, e.g. via the same mould/press. Alternatively, the shoulder may be subsequently pressed into the storage portion.

[Container Perforation Region]

Referring to figures 8 to 11 and 16, the perforation region 112 as discussed previously is treated to facilitate comparatively easier perforation by the penetrator 38 (as shown in figures 4A and 4B) than a portion that is not treated, as will be discussed.

Referring to figure 16 the annular ring of the perforation region **112** is arranged as three segments **132**, which are radially bounded by three bridges **134**. The segments **130** are treated and the bridges **134** are not treated.

For the previously discussed example of the penetrator **38**, there are three penetration elements, which are arranged with an equal angular pitch of 120 degrees to each other about the axis **106**. The bridges **134** have a different equal angular pitch: since there are four bridges **134** the angular pitch is 90 degrees about the axis **106**. In this way if the rotational orientation of the container **6** about the axis **106** is unknown, it can be ensured that even if one penetration element happens to be aligned to a bridge **134**, others will not, hence it may be ensured that at least one penetration element entirely penetrates the perforation region **112**, **132** rather than a bridge **134**.

In variant embodiment, which are not illustrated: the penetrator has a number other than three penetration elements, e.g. 2 or 4; perforation region is composed of a number other than four segments, e.g. 3 or 5; it is preferable that the number of segments is different to the number of penetration elements, and; the bridges are omitted so that the penetration region is a continuous ring.

The penetration region **112** is treated via elevated temperature and a pressure via pressing to glassify the wood pulp-based material. The temperature is 100 - 300 degrees C. The pressure is 1×10^5 - 1×10^7 Pa. It will be understood that any suitable temperature and pressure combination may be selected, e.g. the glassification may be achieved via cold pressing, which can include pressing at room temperature but to a higher pressure than for hot pressing. The elevated temperature and pressing force can be applied for 5 – 60 seconds.

The treated perforation region **112** has a reduced thickness. For example, a 0.5 mm thick material may have the thickness reduced to 0.3 mm thickness. The treatment may be applied until said thickness reduction has been achieved.

The size and dimension of the treated perforation region **112** may vary according to the needs to optimize the interaction between the container **6** and the beverage preparation machine.

As used herein the term “glassification” or “glassify” may refer to a change in one or more material properties of the wood pulp material to be more glass like. It may be characterised by one or more of the following material properties (compared to an untreated wood pulp material): a glass transition temperature above ambient temperature; a harder material; a more brittle material; a material with low energy absorption before fracture; a thinner sectioned material; a material with

reduced fibre interstices; reduced water absorption; increased stiffness, and transitioning the material to a glassy state.

In variant embodiments, alternative treatments are implemented including: applying a coating, and; scoring to reduce material cross-section. As used herein the term “applying a coating” may refer to the application of a coating to the wood pulp-based material to close pores/interstices between the fibres and/or to act as a barrier. This may provide reduced water absorption, which may be advantageous for the reasons previously given. This may also provide a more brittle type failure, which may be advantageous for the reasons previously given. The coating may comprise caramelised sugar or starch or other suitable coating. As used herein the term “scoring” may refer to the removal of a portion of material by a cutting tool or otherwise. The portion of material that is removed may be up to 50% of the material thickness. The portion of material may be one or more of: a line; a perimeter of the perforation region; the area of the perforation region.

By treating the perforation region **112** of the wood pulp-based container **6** with the disclose treatment method, it may be easier to penetrate by the penetrator **38** than for a region that is not treated. This may be characterised by one or more of the following ways: a perforation of the perforation region that comprises a more brittle type failure mode with comparatively lower energy absorption rather than a ductile type failure mode with comparatively higher energy absorption of an untreated region; less displacement of the penetrator to achieve full penetration (e.g. due to a reduced thickness of the perforation region and/or less movement of the perforation region with the penetrator) and; a penetration with a lower maximum force.

For a perforation region **112** that is treated to be 0.3 mm thick from 0.5 mm, for penetration elements with a total penetration area of 6 – 15 mm², perforation may occur for 1 – 50 N or 2 – 10 N.

The presented values of the perforation region **112** on the container **6** may be defined differently and may vary depending on the beverage preparation machine's characteristics.

At **block 74**, as shown in figure 7, the previously described preparation process can be implemented by: arranging the container **6** in the container holding portion **34** of the processing unit **14** of the machine **2**. The perforation region **112** of the container **6** can be penetrated by the penetrator **38** to form inlets.

Thanks to the combination of the treated perforation region **112**, the stiffener portions **110** and the shoulder **120** (and rim **122**), the rigidity of the base **78** is increased allowing thereby an

improved and efficient penetration of the penetrator 38 to form inlets. During perforation of the base by the penetrator, the container resists displacement and the base is less crushed.

A method of forming the storage portion can include wet forming the storage portion. Subsequently the perforation region 112 may be treated by one of the previously described processes. The bridges 134 may be formed by a press shaped to treat only the segments 132.

In variant embodiments, which are not illustrated: other parts of the container 6 may be treated by the processes disclosed herein in addition to or instead of the perforation region 112.

For example, the flange portion 60 may be treated to provide an improved surface to carry a code on the lower surface 72 of the flange portion 60. In particular, a heat and pressing process may be applied to reduce a thickness of a flange portion 60 when formed of wood pulp-based material so that the flange portion 60 has a comparable thickness to that of a container formed of conventional materials (e.g. aluminium) to ensure compatibility with existing machines. The heat and pressing process may also provide a more consistent surface to act as a substrate for the code, which may improve code reading reliability. In such an example the preparation process can include a step of reading the code to extract preparation information therefrom. The step of reading the code can include rotating the code relative to a code reader.

It will be appreciated that any of the disclosed methods (or corresponding apparatuses, programs, data carriers, etc.) may be carried out by either a host or client, depending on the specific implementation (i.e. the disclosed methods/apparatuses are a form of communication(s), and as such, may be carried out from either 'point of view', i.e. in corresponding to each other fashion). Furthermore, it will be understood that the terms "receiving" and "transmitting" encompass "inputting" and "outputting" and are not limited to an RF context of transmitting and receiving radio waves. Therefore, for example, a chip or other device or component for realizing embodiments could generate data for output to another chip, device or component, or have as an input data from another chip, device or component, and such an output or input could be referred to as "transmit" and "receive" including gerund forms, that is, "transmitting" and "receiving", as well as such "transmitting" and "receiving" within an RF context.

As used in this specification, any formulation used of the style "at least one of A, B or C", and the formulation "at least one of A, B and C" use a disjunctive "or" and a disjunctive "and" such that those formulations comprise any and all joint and several permutations of A, B, C, that is, A alone,

B alone, C alone, A and B in any order, A and C in any order, B and C in any order and A, B, C in any order. There may be more or less than three features used in such formulations.

In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word 'comprising' does not exclude the presence of other elements or steps than those listed in a claim. Furthermore, the terms "a" or "an," as used herein, are defined as one or more than one. Also, the use of introductory phrases such as "at least one" and "one or more" in the claims should not be construed to imply that the introduction of another claim element by the indefinite articles "a" or "an" limits any particular claim containing such introduced claim element to inventions containing only one such element, even when the same claim includes the introductory phrases "one or more" or "at least one" and indefinite articles such as "a" or "an." The same holds true for the use of definite articles. Unless stated otherwise, terms such as "first" and "second" are used to arbitrarily distinguish between the elements such terms describe. Thus, these terms are not necessarily intended to indicate temporal or other prioritization of such elements. The mere fact that certain measures are recited in mutually different claims does not indicate that a combination of these measures cannot be used to advantage.

Unless otherwise explicitly stated as incompatible, or the physics or otherwise of the embodiments, example or claims prevent such a combination, the features of the foregoing embodiments and examples, and of the following claims may be integrated together in any suitable arrangement, especially ones where there is a beneficial effect in doing so. This is not limited to only any specified benefit, and instead may arise from an "ex post facto" benefit. This is to say that the combination of features is not limited by the described forms, particularly the form (e.g. numbering) of the example(s), embodiment(s), or dependency of the claim(s). Moreover, this also applies to the phrase "in one embodiment", "according to an embodiment" and the like, which are merely a stylistic form of wording and are not to be construed as limiting the following features to a separate embodiment to all other instances of the same or similar wording. This is to say, a reference to 'an', 'one' or 'some' embodiment(s) may be a reference to any one or more, and/or all embodiments, or combination(s) thereof, disclosed. Also, similarly, the reference to "the" embodiment may not be limited to the immediately preceding embodiment.

As used herein, any machine executable instructions, or compute readable media, may carry out a disclosed method, and may therefore be used synonymously with the term method, or each other.

The foregoing description of one or more implementations provides illustration and description, but is not intended to be exhaustive or to limit the scope of the invention to the precise form disclosed. Modifications and variations are possible in light of the above teachings or may be acquired from practice of various implementations of the present disclosure.

LIST OF REFERENCES

2 System

4 Machine

14 Processing unit

20 Container processing unit

32 Extraction unit

34 Container holding portion

36 Closing member

38 Injection head/penetrator

40 Beverage outlet

22 Fluid conditioning system

24 Reservoir

26 Pump

28 Heat exchanger

30 Outlet

16 Electrical circuitry

48 Control electrical circuitry

50 Input unit

52 Processor

54 Feedback system

18 Code reading system

46 Image capturing unit

6 Container

56 Closing member

62 Interior surface

64 Exterior surface

58 Storage portion

74 Cavity

76 Sidewall

80 Proximal edge

- 82 Distal edge
- 120 Shoulder
 - 122 Rim
 - 124 Outer surface
- 126 Void defining region
- 78 Base
 - 84 Peripheral edge
 - 112 Perforation region
 - 132 Segments
 - 134 Bridges
- 110 Stiffener portions
 - 114 Channel
 - 116 Sidewall
 - 118 Base
- 60 Flange portion
 - 66 Interior edge
 - 68 Exterior edge
 - 70 Upper surface
 - 72 Lower surface
- 44 Code element

CLAIMS

1. A container for use with a machine for preparing a beverage and/or foodstuff or a precursor thereof, the container including:
 - a storage portion comprising a cavity with sidewall, a flange portion and a base for containing a precursor material, and
 - a closing member to close the storage portion,wherein at least part the storage portion, is formed of wood pulp-based material, and
wherein the storage portion comprises two or more of the
 - a perforation region, arranged at the base of the storage portion, which is treated to facilitate comparatively easier perforation by a penetrator of the machine than a portion that is not treated;
 - stiffener portions, arranged to extend along the base from a periphery to contiguous the perforation region to stiffen the base to resist displacement when the base is perforated by a penetrator of the machine; and
 - a shoulder that extends outwardly from the flange portion to a rim of the sidewall proximal the base, to define a void defining region of the sidewall that is arranged between the shoulder and the base to increase the rigidity of the base.
2. The container of claim 1, wherein the shoulder is arranged to extend along the periphery of the sidewall to a region contiguous the stiffener portions.
3. The container of either of claims 1 or 2, wherein the stiffener portions comprise discrete units that are circumferentially disposed about a circumference of the sidewall of the container.
4. The container of any of claims 1 to 3, wherein the stiffener portions protrude into an interior of the storage portion and not outwardly from an exterior.

5. The container of any preceding claim, wherein the stiffener portions are arranged as channels that bridge the base and proximal region of the sidewall.
6. The container of either of claims 4 or 5, wherein the stiffener portions have a maximum depth (X) of less than 10 mm and greater than 2 mm.
7. The container of any of claims 1 to 6, wherein the stiffener portions are arranged to extend in a depth direction along the sidewall from a junction with the base to a distance (Y) of less than 40% of a total depth D between the storage portion and base.
8. The container of any of claims 1 to 7, wherein the stiffener portions are arranged to extend along the base from a periphery to a radii Z of greater than 30% of the total radii R of the base.
9. The container of any preceding claim, wherein the shoulder has a depth distance S between the flange portion and the rim of the sidewall is comprised between 50 and 80% of a total depth D of the storage portion.
10. The container of any preceding claim, wherein the perforation region includes one or more of the following material properties compared to a portion that is not treated.
 - reduced water absorbency;
 - increased brittleness;
 - increased stiffness, and;
 - reduced thickness.

11. The container of any preceding claim, wherein the perforation region is arranged as an annular ring, which is central about an axis of rotation of the container.
12. The container of claim 11, wherein the annular ring is arranged as segments, which are bounded by bridges that are not treated.
13. The container of claim 12 where the bridges are arranged to have a different angular pitch compared an angular pitch of elements forming the penetrator of the machine.
14. The container of any preceding claim, wherein the perforation region is configured to be perforated by the penetrator element with a total area of $6 - 15 \text{ mm}^2$. when subject to at least 1 - 10 Newtons.
15. The container of any preceding claim, wherein the stiffener portions are arranged to prevent a perforation region of the base displacing by more than $0.5 - 2 \text{ mm}$ in a depth direction, when the perforation region is subject to a compressive force in the depth direction of 1 – 50 N, which is applied by the penetrator.
16. A system comprising a container of any preceding claim and a machine for preparing a beverage and/or foodstuff or a precursor thereof,
 - the machine including:
 - a processing unit for processing the precursor material of the container, and;
 - electrical circuitry to control the processing unit.
17. Use of the container of any of claims 1 to 15 for the system of claim 16.

18. A method of preparing a beverage and/or foodstuff or a precursor thereof from the precursor material of the container, the method comprising:

- perforating with a penetrator of said machine a perforation region, which is treated to facilitate comparatively easier perforation by the penetrator of the machine than a portion that is not treated,
- supplying conditioned fluid to precursor material of the container via the perforation, and
- processing the precursor material.

19. A method of preparing a beverage and/or foodstuff or a precursor thereof, the method comprising:

- arranging a container containing precursor material in a container holding portion of a processing unit of a machine,
- engaging a shoulder of a sidewall of the container that is profiled to maintain a void between a portion of the sidewall between a base and the shoulder,
- penetrating a wood pulp-based portion of a container with a penetrator to provide fluid inlets and resisting displacement of the wood pulp-based portion during said penetration with stiffener portions,
- transmitting fluid into the container via the fluid inlets, and
- processing the precursor material.