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(54) **Title:**
**CAPSULE, SYSTEM AND METHOD FOR THE
PREPARATION OF A BEVERAGE AND A METHOD FOR
MANUFACTURING SUCH A CAPSULE**

(57) **Abstract:**
Capsule (2) for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, for instance roast and ground coffee, comprising a circumferential first wall (14), a second wall (16) closing the circumferential first wall at a first end (18), a perforate and/or porous third wall (20) closing the circumferential first wall at a second, open, end (22) opposite the second wall arranged for draining the prepared beverage from the capsule, wherein the first, second and third wall enclose an inner space (24) comprising the extractable product, wherein the extractable product in the inner space has particles falling within a preselected distribution by weight, wherein a 10th percentile of the particle size is 20 - 60 µm, wherein a 50th percentile of the particle size is 400-600 µm and wherein a 90th percentile of the particle size is 700-1000 µm. The invention further relates to a method for manufacturing such a capsule, a system comprising such a capsule for preparing a beverage and a method for preparing of a beverage.

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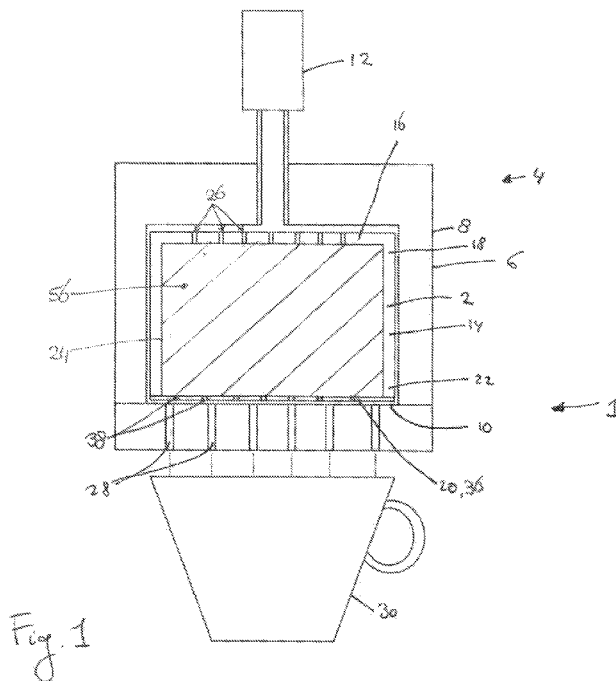
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(54) **Title:** CAPSULE, SYSTEM AND METHOD FOR THE PREPARATION OF A BEVERAGE AND A METHOD FOR MANUFACTURING SUCH A CAPSULE



(57) **Abstract:** Capsule (2) for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, for instance roast and ground coffee, comprising a circumferential first wall (14), a second wall (16) closing the circumferential first wall at a first end (18), a perforate and/or porous third wall (20) closing the circumferential first wall at a second, open, end (22) opposite the second wall arranged for draining the prepared beverage from the capsule, wherein the first, second and third wall enclose an inner space (24) comprising the extractable product, wherein the extractable product in the inner space has particles falling within a preselected distribution by weight, wherein a 10th percentile of the particle size is 20 - 60 μm, wherein a 50th percentile of the particle size is 400-600 μm and wherein a 90th percentile of the particle size is 700-1000 μm. The invention further relates to a method for manufacturing such a capsule, a system comprising such a capsule for preparing a beverage and a method for preparing of a beverage.

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Title: Capsule, system and method for the preparation of a beverage and a method for manufacturing such a capsule

The invention relates to a capsule for preparing a predetermined quantity of beverage suitable for consumption using an extractable or a soluble product, for instance roast and ground coffee, comprising a circumferential first wall, a second wall closing the circumferential first wall at a first end, a
5 perforate and/or porous third wall closing the circumferential first wall at a second, open, end opposite the second wall arranged for draining the prepared beverage from the capsule, wherein the first, second and third wall enclose an inner space comprising the extractable product.

Such capsules are known per se and can be used in an apparatus for
10 preparing a beverage. They provide convenience in use as well as reproducible extraction conditions, resulting in easy preparation of a cup of coffee with a constant quality. The known capsule can be an open capsule, comprising a circumferential wall and an exit area adapted for draining prepared beverage from the capsule. In the inner space of the capsule, an amount of extractable
15 product, such as roast and ground coffee is provided, for instance by providing an amount of coffee with a smaller volume than the volume of the inner space. Such a capsule can be used in a beverage production apparatus in which a liquid under pressure enters the capsule in order to interact with the extractable product in the capsule and to drain the beverage from the capsule
20 out of the apparatus into a container, such as a coffee cup.

When using the known capsule with an open exit area and loosely provided roast and ground coffee, water supplied to the capsule may rush through the capsule resulting in a less than desired pressure build-up inside the capsule, thereby extracting the coffee with a relatively low extraction
25 pressure. This may result in an uncontrolled beverage preparation process which may adversely affect the prepared beverage. Especially, the quality of the coffee may be inferior, for instance because due to a lower extraction

pressure, the coffee may be watery or an inferior foam layer due to a lower CO₂ content of the coffee beverage that occurs when extracting at lower extraction pressure, while CO₂ is important for creating foam.

It is an object of the invention to provide an improved capsule
5 provided with an extractable or soluble product for the preparation of a beverage and more specifically to at least diminish the above problem. In particular, it is an object of the invention to provide an improved capsule comprising roast and ground coffee which results in improved taste of coffee prepared using such capsule.

10 Thereto, according to a first aspect of the invention, a capsule of the above described type is provided, wherein the extractable product in the inner space of the capsule has particles falling within a preselected range of distribution by weight, wherein a 10th percentile of the particle size is 20 – 60 μm, preferably smaller than 40 μm, wherein a 50th percentile of the particle
15 size is 400 – 600 μm, preferably 450-550 μm and wherein a 90th percentile of the particle size is 700 – 1000 μm, preferably 825-950μm.

Preferably, the capsule is provided with openings in an exit area thereof, which may be substantially equally distributed about a cross-section of the exit area. It will be appreciated that a flange of the capsule may not be
20 regarded as a suitable exit area.

It is found that when such capsule is being used for preparing coffee, the particles having smaller sizes in the given distribution by weight substantially do not dwell inside these openings thereby improving coffee preparation process due to improved flow patterns. In addition, it is found that
25 an amount of undesirable sediment in a cup decreases when a capsule provided with exit openings is used with respect to a capsule which is intended to be torn during use. In particular, it is found that in an open capsule according to an aspect of the invention provided with openings in the exit area particles may be sized for matching these openings thereby improving flow
30 patterns of a liquid exiting the capsule. In addition, it is found that such

matching may lead to an improved oil concentration in the resulting beverage as well as to an improved Dry Matter Accumulation (DMA) while preserving the setting time substantially the same as in the capsule known from the prior art. More in particular, such a particle size distribution of the roast and
5 ground coffee inside the capsule prevents collapsing of the coffee bed upon pressurizing the coffee with water.

Advantageously the coffee is compacted inside the capsule. For example, a suitable coffee starting material may be compressed inside the
10 capsule.

It will be appreciated that particles of the coffee starting material entering the capsule (thus not yet compacted) may have somewhat smaller dimensions than the particles of the end product set forth in claim 1.

For example, particles of the coffee starting material may have the
15 following distribution by weight: a 10th percentile of the particle size may be 25 – 55 μm , preferably less than 40 μm , a 50th percentile of the particle size may be 450-550 μm and a 90th percentile of the particle size may be 600 – 800 μm .

It is understood that due to the step of compacting, for example by compressing the coffee starting material, the particle size may increase due to
20 particles sticking together.

In the capsule, as a result, due to the compression of the coffee, the relatively small particles may be enclosed by the relatively large particles such that the relatively small particles can not displace towards the exit filter before the preparation of the beverage. When supplying water to the inner
25 space of the capsule, the relatively small particles may flow with the water towards the exit filter to form the flow restriction together with said exit filter. At the same time such particle size distribution provides a high quality coffee with a good taste. If the overall particle size is too small, the coffee bed may collapse such that prepared beverage can not easily pass through resulting in
30 an undesired high beverage preparation time. If, on the other hand, the overall

particle size is too large, the supplied fluid will rush through the coffee, resulting in watery coffee beverage comprising a low concentration of dissolved dry matter without having a foam layer.

It is noted that the above mentioned preferential particle size
5 distribution according to the invention is determined by means of a commonly known Sympatec analyser that is suitable for determining particle distribution and size in dry products. Such an analyser may be a Sympatec Central Unit “Helos” used in combination with a dry dispersion system Rodos T4.1 unit. The used measuring range R7 comprises 0.5/18.0 - 3500µm. A sample is positioned
10 in the measuring unit. By means of laser diffraction technology, the particle size distribution of said sample is determined. The light emitted by the laser is diffracted by the sample particles. The amount of diffraction is dependent on the particle size of the roast and ground coffee of the sample. The diffused light is detected by a detector after passing a lens, said lens being a R7 lens.

15

It will be appreciated that coffee may be suitably compacted prior to being inserted into the capsule and/or within the capsule. Compacting prior to introduction into the capsule may be achieved using a suitable plunger. It will be appreciated that this operation may be preceded by a step of densification
20 wherein a flow of the extractable product is pushed through a narrow diaphragm under pressure. Compacting in the capsule may be achieved by suitably compressing the coffee starting material in the capsule. By compressing the coffee starting material in the capsule, particles of the roast and ground coffee are pressed against the walls of the inner space of the
25 exchangeable capsule, thereby preventing occurrence of preferential fluid flow paths along the respective walls of the capsule. This also may be advantageous in case the capsule has to be placed in an apparatus such that the exit filter is directed sideways, e.g extending in a substantially vertical plane. By providing a capsule with compacted coffee inside, also in a rotated position of the
30 capsule, the coffee stays located next to the entire exit filter, thereby

preventing preferential fluid flow paths. Consequently, the supplied fluid, such as water, is directed from the entrance area through the coffee bed to the exit area of the capsule independent of the position of the capsule, providing a controlled beverage preparation. Thus, by compressing the coffee, the speed of the fluid flow can be controlled between the entrance area and the exit area of the exchangeable capsule. Furthermore, such a compressed coffee bed together with the exit area of the coffee provides a desired flow restriction within the capsule during preparation of the beverage. This allows a higher extraction pressure building up within the inner space of the capsule, thereby providing a higher extraction pressure to build up in the capsule. For instance, such that a coffee beverage with a desired strength and with a higher CO₂ content resulting in a high quality coffee beverage with a foam layer may be provided.

Preferably, the capsule according to the invention comprises an amount of coffee suitable for preparing a single portion of beverage, preferably a single cup of the beverage, e.g. from 30 – 200ml of the prepared beverage. The capsule may therefore comprise 4.0 – 8 grams, preferably 4.9 - 5.7 grams, preferably approximately 5.3 ± 0.2 grams of roast and ground coffee. For instance, a capsule comprising approximately 5.3 grams may be used for preparing a cup of espresso coffee. The exchangeable capsule, thus, is a single-portion-pack. Hence, the capsule is suited for preparing a predetermined amount of coffee by supplying a predetermined amount of hot water under high pressure to the capsule. A capsule comprising the mentioned amount of coffee provides a coffee beverage with a favourable amount of foam, a desired amount of soluble dry matter extracted from the coffee starting material. It is noted that a favourable amount of foam preferably is at least about 5 ml of foam, or more, for instance 9 ml of foam, on top of a prepared beverage comprising about 40 ml. Furthermore, the capsule comprises a distribution of the particles loose enough to prevent formation of a flow restriction in the entire coffee bed preventing an undesired long preparation time of the beverage and a large amount of coffee oil comprised in the beverage.

In further elaboration of the invention, the inner space of the capsule preferably has a volume of approximately 10-14 ml, preferably 11.5 – 12.5 ml, more preferably approximately 11.8 ml.

It is advantageous if the entire inner space is occupied by the extractable product, for instance the roast and ground coffee. Hence, optimum use may be made of the internal volume of the capsule when matching densities of the ground coffee are used. This further provides the advantage that the extractable product cannot be displaced entirely inside the inner space when the fluid flows through the capsule, so that no preferential paths can be formed. Furthermore, because the entire inner space is occupied with the coffee, no water will remain inside the capsule between the coffee and the respective side walls after preparing the beverage. Therefore, the capsule can be removed from the apparatus with a minimum risk of soiling the apparatus because of water leaking from the capsule.

It has been found by the applicant, that it is advantageous according to a further elaboration of the invention, if the roast and ground coffee is compressed such that the compressed coffee in the inner space of the capsule comprises a substantially homogenous density. During use, the particles of such homogenous coffee inside the capsule may be redistributed resulting in a relatively loose coffee bed layer adjacent the second wall, thus the entrance area of the capsule and a relatively compact coffee bed layer adjacent the third wall, thus the exit area of the capsule. Such compact coffee bed layer together with the exit filter provides a filtering capacity of the capsule with a desired pressure drop. Thus, the compact coffee bed layer and the exit filter together provide retarding of the outflow of the prepared coffee beverage from the capsule.

According to another aspect of the invention, the third wall comprises an exit filter for draining prepared beverage from the capsule, wherein the exit filter for instance is formed by a porous or perforate sheet. The exit filter may be formed by a woven or non-woven fibrous sheet, such as

filtering paper, or a film, such as a polymeric film, provided with a plurality of exit openings. In use such an exit filter together with a compact coffee bed layer adjacent the filter provides a desired flow restriction that may result in a coffee beverage with a good quality and good taste. By using filtering paper as the exit filter a low-cost third wall is provided. Furthermore, the third wall being of filtering paper may result in filtering oil from the beverage, i.e. from the coffee, before supplying the coffee to the container, such as the cup. This may be advantageous to reduce the amount of oils in the coffee which may adversely affect the taste and/or quality of the coffee. It is especially advantageous to filter cafestol from the coffee. Moreover, the third wall being porous may provide the advantage that the beverage can be drained from the capsule over substantially the entire cross section of the inner space. Hence, the beverage can flow out the inner space very homogeneously. This may prevent the existence of preferential fluid flow paths inside the inner space. Preferential fluid flow paths are known to reduce reproducibility of the process of preparing the beverage.

It is advantageous if the exit filter, for instance of the polymeric film, comprises 80 - 140 exit openings, wherein an opening diameter is between $0,20 \text{ mm} \pm 0.05\text{mm}$ and $0.40 \text{ mm} \pm 0.05\text{mm}$, preferably approximately $0,3\text{mm} \pm 0.05\text{mm}$. Such exit openings together with the relatively small coffee particles that are redistributed during water supply and located adjacent the openings may provide the desired flow restriction and thus pressure drop. Due to said openings, the prepared beverage will leave the capsule with a desired speed such that the preparation time will not be too long, for instance no more than 40 seconds, preferably no more than 30 seconds. Furthermore, the openings are small enough to prevent coffee particles from leaving the capsule and ending up in the cup with prepared coffee beverage. The preferred amount of openings in the exit filter enables the exit filter together with the compact coffee bed layer adjacent the filter to form a desired flow restriction such that a coffee beverage with an acceptable oil balance, a desired brewing strength and

an acceptable preparation time is obtained. Such a coffee beverage will have a good quality and good taste.

In further elaboration, the first circumferential wall is substantially rigid. In general, the circumferential first wall may have any shape such as cylindrical, hemispherical, frustoconical or polygonal, such as hexagonal or octagonal.

Preferably, the capsule comprises an entrance filter, wherein the entrance filter has a flow resistance that is lower than the flow resistance of the compacted extractable product in combination with the exit filter, avoiding excessive pressure build-up upstream of the entrance filter. This is favourable since such upstream pressure build-up does not contribute to the brewing of the beverage.

According to a further aspect of the invention, the extractable product is compacted into a tablet from the coffee starting material. This provides the advantage that the risk of preferential fluid flow paths occurring in the compacted extractable product tablet is reduced. It will be appreciated that when using the compacted tablet, the second wall may be omitted from the capsule, as the risk of spilling extractable product is greatly reduced.

In further elaboration of the invention, the tablet may comprise at least one bore extending from the side of the tablet facing the second wall in the direction of the third wall. The bore thus provides an infusion means for wetting the tablet in a homogeneous manner.

It is also possible that the extractable product is compacted into a plurality of tablets, preferably of mutually different packing density. It is for instance possible that the extractable product is provided as a single stack of tablets having mutually different degrees of compacting. It is for instance possible that the degree of compacting increases per tablet in the direction from the second wall to the third wall. In this way the effort required to completely wet a tablet will also increase in the direction from the second wall to the third, ensuring that each upstream tablet has been properly wetted

when wetting a more downstream tablet, thus providing very homogeneous wetting of the total volume of extractable product.

The invention further relates to a method for manufacturing the above described capsule, comprising:

5 - providing a coffee receiving cup comprising the circumferential first wall and one of the second and third walls defining an inner space arranged for receiving roast and ground coffee;

 - providing an amount of roast and ground coffee in the inner space of the coffee receiving cup having a preselected distribution by weight, wherein
10 a 10th percentile of the particle size is 20 – 60 µm, preferably less than 40 µm, wherein a 50th percentile of the particle size is 400 – 600 µm , preferably 450-550 µm and wherein a 90th percentile of the particle size is 700 – 1000 µm, preferably 825-950 µm.

15 It will be appreciated that the step of providing may comprise the step of compressing an amount of roast and ground coffee starting material such that the capsule comprises compacted coffee having the particle distribution as is set forth in claim 1. For example, particles of the coffee starting material may have the following distribution by weight: a 10th
20 percentile of the particle size may be 25 – 55 µm, preferably less than 40µm, a 50th percentile of the particle size may be 450-550 µm and a 90th percentile of the particle size may be 600 – 800 µm.

The total amount of coffee may be provided in the inner space of the capsule and subsequently be compressed to compact said amount of coffee.

25 In an alternative embodiment of the method of the invention, the method may comprise:

 - providing a first part of the amount of roast and ground coffee starting material in the inner space;

 - compressing said first part such that the first part is compacted;

- subsequently providing a further part of the amount of roast and ground coffee starting material on top of the compressed first part in the inner space of the capsule;

- compressing the further part such that the further part is
5 compacted. By alternately providing and compressing parts of the amount of coffee, the coffee may be more easily inserted in the capsule and at the same time risk of spoiling coffee starting material may be reduced.

It will be appreciated that the tablet or tablets may have the pre-determined particle size distribution as is described with reference to claim 1.
10 The coffee starting material may have particle distribution as is set forth in the foregoing.

It is also possible according to a further aspect of the invention, that the coffee starting material that is inserted in the inner space of the capsule is condensed by means of vibration prior to compressing said coffee starting
15 material.

Preferably, the compacted volume of the roast and ground coffee is substantially similar to a volume of the inner space of the coffee receiving cup.

Such a method provides the advantage that distribution of the coffee
20 particles inside the coffee receiving cup of the exchangeable capsule can be determined during the manufacturing process. The distribution of the coffee particles thus can be homogenous, wherein relatively small particles may be enclosed by relatively large particles. Due to the compaction of the coffee, the distribution will not considerably change during for instance transport of the
25 exchangeable capsules. Consequently, the predetermined distribution of the particles inside the capsule may remain intact. By preparing a beverage with such a capsule, the coffee preparation process may be controllable and reproducible.

Furthermore, by compacting the coffee in the inner space of the
30 capsule, a flat surface is provided at the side of the exchangeable capsule to

which the exit filter has to be connected. Such a flat surface enhances tight sealing of the exit filter onto the circumferential first wall of the exchangeable capsule, thereby preventing occurrence of apertures between for instance the foil of the exit filter and the first wall. The latter may result in a capsule of inferior quality that may produce an inferior quality of beverage due to such apertures, coffee and fluid may leak there through without passing the exit filter.

Compaction of the coffee further increases the sealing quality of the exit filter onto the circumferential first wall because the risk of coffee particles being located on the circumferential first wall surface is decreased. Thus, sealing quality of the exit filter along the entire circumferential first wall may not be diminished due to particles between the filter and the wall.

In a further elaboration of the method according to the invention, the roast and ground coffee is compressed with a compressive pressure of substantially 50-300N, preferably 50 – 500N, preferably of substantially 400-600N. Good results have been achieved with a compressive pressure of about 500N.

In order to provide the predetermined amount of roast and ground coffee starting material in the inner space of the coffee receiving cup with a volume of approximately 10-14, ml, preferably of 11.5-12.5 ml, more preferably of approximately 11.8 ml, it is preferable that a pouring volume of the roast and ground coffee starting material (not yet compacted) is preferably in the range of 600-680 ml per 250 grams of coffee starting material. With such a pouring volume, the roast and ground coffee after compression may have a weight of 4.0 – 8 grams, preferably 4.9-5.7 grams, preferably of approximately 5.3 grams \pm 0.2 grams. It will be appreciated that the term starting material refers to a condition of the coffee before it is introduced into the capsule.

Applicant found that if an exchangeable capsule according to the invention comprises coffee with a pouring volume of less than 600ml per 250

grams of coffee starting material, a prepared cup of coffee using said capsule results in a watery cup of coffee without a nice foam layer. It will be appreciated that the pouring volume in this aspect relates to a condition of the coffee before the step of compacting in the capsule. Furthermore, if the pouring
5 volume is less than 600ml per 250 grams the coffee beverage may comprise a relatively large amount of coffee oil, which negatively influences the quality of the prepared beverage. A high pouring volume, higher than the preferred volume as mentioned above, is also undesirable because it may result in a too long beverage preparation time.

10 It is noted that the pouring volume of coffee starting material is determined by measuring the volume of 250 g of coffee after grinding post densification. In order to determine this volume, an amount of roast and ground coffee starting material is poured from a funnel into a tray provided there under to that end, which tray has a volume of 250 ml. The tray has a
15 slide which is closed, so that the volume of coffee grindings of 250 ml remains in the tray. Then, the weight of the coffee grindings in the tray is determined and converted into a pouring volume expressed in ml/250g.

Furthermore, it is desirable that according to a further aspect of the
20 invention, the roast and ground starting material has a moisture content of 1.0 – 4.0 %, preferably of 1.5 – 2.2 %, more preferably of approximately 1.5% before compacting the roast and ground starting material in the inner space of the capsule. The moisture content of the coffee starting material is formed in that the coffee starting material is quenched with moisture before the coffee
25 starting material is ground. The moisture content is determined by measuring an extent of weight loss of 5 g coffee starting material as a result of drying the coffee starting material in an oven for 3 hours at 103°C.

Preferably, according to a further embodiment of the method
according to the invention, the coffee beans intended for the roast and ground
30 coffee starting material are roasted during approximately 250-1000 seconds,

preferably during 450-700 seconds, wherein a degree of roast of the roast and ground coffee starting material preferably is in the range of 30-60. An exchangeable capsule comprising such roast and ground coffee provides a cup of coffee beverage with a nice flavour comprising an acceptable amount of coffee oil. Such a degree of roast further provides roast and ground coffee starting material that can be compacted in a desired manner with a desired pressure as mentioned before. The degree of roast of the coffee starting material is determined by measuring the reflection of light on a levelled amount of ground coffee starting material. This can be carried out with, for instance, a colour analyzer LK100, type LMG163 of Dr. Bruno Lange GmbH. An amount of light, for instance of a wavelength of 640 nm, is directed at a sample comprising said levelled amount of grindings. Depending on the darkness of the grindings, an amount of light is reflected and measured. The value indicates the degree of roast. Said colour analyzer is calibrated daily by subsequently using two calibration tiles. Thereafter said calibration tiles are measured and then the sample is measured. If needed, the roasted beans are grind to a particle size fine 3/4, having an average particle size of approximately 0.39mm. Levelling off the coffee should be done by keeping a ruler upright and making a 90 degree angle with the surface of the coffee. The coffee is levelled off in three smooth movements (to and fro) over the brim of the sample-dish. If obvious irregularities are determinable on the coffee surface, levelling should be done again.

In further elaboration of the invention, the coffee beans are grinded to provide roast and ground starting material with a particle size distribution by weight, wherein a 10th percentile of the particle size is 25-55 μ m, wherein a 50th percentile of the particle size is 400-550 μ m, and wherein a 90th percentile of the particle size is 600-800 μ m. When compressing such roast and ground starting material in the inner space of the capsule, a predetermined homogenous distribution of the particles can be provided as explained before having the particle distribution as is set forth in claim 1.

The invention also relates to a capsule obtainable by the above described method and to a system for preparing a predetermined quantity of beverage suitable for consumption according to claim 27 and to a method for preparing a predetermined quantity of beverage suitable for consumption
5 according to claim 29.

Further advantageous embodiments of the capsule, the method for manufacturing such a capsule, the system and the method for preparing a beverage according to the invention are set forth in the dependent claims.

The invention will now be further elucidated by means of, non-
10 limiting, examples referring to the drawing, in which

Fig 1 shows an example of a first embodiment of a system for preparing a beverage according to the invention;

Fig. 2 shows a first embodiment of a capsule according to the invention;

15 Fig. 3 shows the capsule of Fig. 2 during preparation of a beverage;

Fig. 4 shows a second embodiment of a capsule according to the invention;

Fig. 5 shows a third embodiment of a capsule according to the invention; and

20 Fig. 6 shows a fourth embodiment of a capsule according to the invention;

It is noted that identical or corresponding elements in the different drawings are indicated with identical or corresponding reference numerals.

Fig. 1 shows an example of a first embodiment of a system 1 for
25 preparing a predetermined quantity of beverage suitable for consumption using an extractable product according to the invention. The system 1 comprises an exchangeable open capsule 2, and an apparatus 4. The apparatus 4 comprises a receptacle 6 for holding the exchangeable capsule 2. In Fig. 1, a gap is drawn between the capsule 2 and the receptacle 6 for clarity. It will be
30 appreciated that, in use, the capsule 2 may lie in contact with the receptacle 6.

In this example the receptacle 6 has a shape complementary to the shape of the capsule 2. In this example the receptacle 6 comprises an upper part 8 and a support surface 10.

The apparatus 4 further comprises a fluid dispensing device 12 for
5 supplying an amount of a fluid, such as hot water, under a high pressure, of e.g. more than approximately six bars (absolute pressure), to the exchangeable capsule 2.

In the system 1 shown in Fig. 1, the exchangeable capsule 2
comprises a substantially rigid circumferential first wall 14, a second wall 16
10 closing the circumferential first wall 14 at a first end 18, and a third wall 20 closing the circumferential first wall 14 at a second, open, end 22 opposite the second wall 16. The circumferential first wall 14, the second wall 16 and the third wall 20 enclose an inner space 24 comprising the extractable product, in this example roasted and ground coffee. In this example, the exchangeable
15 capsule 2 comprises an amount of extractable product, e.g. approximately 4.9-5.7 grams of roasted and ground coffee, preferably of approximately 5.3 grams ± 0.2 grams, suitable for preparing a single portion of the beverage, preferably a single cup of the beverage, e.g. from 30-200ml of the prepared beverage.

In the capsule 2 according to the invention roast ground coffee is
20 provided whose particles are falling within a preselected distribution by weight, wherein a 10th percentile of the particle size is 20 – 60 μm , preferably less than 40 μm , wherein a 50th percentile of the particle size is 400 – 600 μm , preferably 450-550 μm and wherein a 90th percentile of the particle size is 700 – 1000 μm , preferably 825-950 μm .

25 It is found that such particle distribution has advantageous effect on decreasing the brew time and amount of sediment in the cup. However, it will be appreciated that there is interplay between the following parameters: grinding size, amount of coffee, amount and a dimension of the openings in the exit area of the third wall and the brew time and the sediment accumulated in
30 the cup.

For example, by increasing the grinding size brew time and amount of the sediment in the cup may be decreased to an advantage. It is found that the size distribution of the particles in the open capsule according to the invention amount of coffee necessary for producing a tasteful coffee drink may
5 be decreased, which has an economic advantage.

Dependent on the desired strength of the prepared beverage the amount of extractable product may vary. For instance for preparing a cup of espresso coffee, the capsule 2 may comprise approximately 5.3 grams and for
10 preparing a cup of coffee lungo, the capsule 2 may comprise approximately 6.0 grams. In another embodiment of the invention, the capsule may also comprise other amounts between 4.0 – 8 grams, preferably between 4.9 – 5.7 grams of coffee. The inner space 24 may have a volume of approximately 10-14 ml, preferably 11.5 – 12.5 ml, more preferably approximately 11.8 ml. The
15 exchangeable capsule, thus, is a single-portion-pack. According to a further aspect of the invention, the extractable product in the inner space 24 of the capsule 2 is compacted.

In the example of Fig. 1, the circumferential first wall 14 is substantially rigid. The circumferential first wall 14 may e.g. comprise a
20 plastics material and may be formed by e.g. injection moulding, vacuum-forming, thermoforming or the like.

In this example the second wall 16 is integral with the circumferential first wall 14. In this example the second wall 16 is substantially rigid and comprises a plurality of entrance openings 26 for
25 allowing the fluid to enter the capsule 2. The second wall 16 provides an entrance filter of the capsule 2.

In this example the third wall 20 is flexible and sheet-shaped. Further, in this example the third wall is porous. The third wall 20 is in this example manufactured from filtering paper. In this example the filtering paper
30 comprises polyethylene (PE) fibres. In this example the third wall 20 is

connected to the circumferential first wall 14 by heat sealing. In this example the third wall 20 forms an outermost boundary of the capsule 2 in an axial direction thereof. It can be seen from Fig. 1 that the third wall 20 abuts against the support surface 10 of the receptacle 6.

5 The system 1 shown in Fig. 1 is operated as follows for preparing a cup of coffee.

 The capsule 2 is placed in the receptacle 6. The third wall 20 is brought into abutment with the support surface 10. The fluid, here hot water under pressure, is supplied from the fluid dispensing device 12 to the
10 extractable product in the inner space 24 through the entrance openings 26. The fluid dispensing device 12 may be adapted to supply the water to the exchangeable capsule 2, under a pressure of approximately 4-20 bars, for instance 9-15 bars, preferably about 6 bars. Good results have been obtained with the pressure of about 6 bars build-up in the fluid dispensing device. The
15 water will wet the coffee grounds and extract the desired substances to form the coffee beverage. The prepared coffee will drain from the capsule 2 through the porous third wall 20. The coffee beverage is further drained from the receptacle 6 via a plurality of outlets 28, and may be supplied to a container 30 such as a cup. During the supply of the water to the compacted coffee in the
20 inner space of the capsule 2, coffee particles are redistributed in the inner space 24 of the capsule 2, such that a relatively loose coffee bed layer L adjacent the second wall 16 and a relatively compact coffee bed layer C adjacent the third wall 20 is formed (see Fig. 3). The relatively small particles S are displaced together with the water towards the exit filter forming third
25 wall 20 and will be located adjacent openings 38 of the exit filter 20. Said small particles S will together with the exit filter 36 form the flow restriction of the capsule 2 (see Fig. 3) providing a desired pressure drop and thus a desired extraction pressure inside the capsule 2, such that the soluble dry matter from the compacted coffee can be extracted and a cup of beverage with a desired
30 brewing strength and quality is obtained.

In the example of Fig. 1 the plurality of entrance openings 26 is distributed over substantially the entire second wall 16. Thus, the fluid is supplied to the extractable product via the plurality of entrance openings 26, which causes the extractable product to be wetted over substantially the entire cross section of the capsule 2. Hence, a very homogeneous supply of fluid to the extractable product is obtained. Thus, the risk of occurrence of preferential paths via which the fluid flows through the extractable product is greatly reduced.

In another (not shown) embodiment of the capsule 2 according to the invention, the third wall 20, forming the exit filter of the capsule 2, through which the beverage, here coffee, can drain from the capsule 2, is formed by a porous sheet, such as filter paper. The entire third wall 20 may then be formed as the porous sheet. For example, the third wall 20 may form a substantially continuous fluid-permeable sheet spanning substantially the entire second open end 22 of the capsule 2. Thus, the fluid can drain from the capsule 2 over a large area. Hence, a very homogeneous drain of beverage from the extractable product is obtained. Thus, the risk of occurrence of preferential paths via which the fluid flows through the extractable product is greatly reduced.

It will be appreciated that in other not shown embodiments of the system, the apparatus may be different than the apparatus as described in the first embodiment of the system. For instance, the apparatus can be provided with a hollow space between the third wall 20 of the capsule 2 and the outlet openings 28 of the apparatus 4. In another example, the apparatus may comprise piercing means for piercing a lid of a hermetically sealed known capsule. Thus it is noted that the capsule according to the invention can be used in any suitable apparatus for preparing a beverage by using high pressure.

Figs. 2-5 show embodiments of capsules according to the invention. In Fig. 2 the second wall 16 is integral with the circumferential first wall 14

like in Fig. 1. The second wall 16 comprises the plurality of entrance openings 26 in the second wall 16. The third wall 20 is formed by a flexible foil 36, e.g. a polymeric foil, provided with a plurality of exit openings 38. In Fig. 2 the capsule 2 comprises an outwardly extending rim 40 at the second end 22 of the circumferential first wall 14. The third wall 20 is attached to the outwardly extending rim 40, e.g. by means of gluing, welding, heat sealing, or the like. Hence, the third wall 20 can be firmly attached to the rim 40. It will be appreciated that it is possible that the outwardly extending rim 40 extends between the upper part 8 of the receptacle 6 and the support surface 10 of the receptacle 6, such that the rim 40 is clamped between the upper part 8 and the support surface 10. Hence, the third wall 20 is clamped against the rim 40 in use, i.e. when the fluid pressure is applied, thus reducing the risk of the third wall 20 separating from the rim 40.

In Fig. 4 the third wall 20 is formed by the flexible porous sheet, such as filter paper. In Fig. 4 the second wall 16 is also formed by a flexible porous sheet, such as filter paper. In this example the second wall 16 is attached to an inwardly extending flange 42. In this example, the second wall 16 is attached to the inner side of the inwardly extending flange 42.

It is appreciated that in other not shown embodiments, the third wall 20 may be formed by a porous sheet such as filter paper or by a polymeric foil, provided with a plurality of exit openings 30, like in Fig. 1 and 2. It will be appreciated that the capsule 2 may comprise any second wall 16 according to any one of the shown embodiments in combination with any third wall 20 according to any one of the shown embodiments. Preferably, the circumferential first wall 14 is substantially rigid. Hence, the capsule 2 will not be prone to deform by shipping and/or handling, so that the capsule 2 will always fit in the receptacle 6. In addition, the circumferential first wall 14 is preferably resilient, so that any possible deformation of the circumferential first wall 14 will be reversed once the force causing the deformation is removed. Nevertheless, it is possible that the circumferential first wall 14 is

formed by a flexible sheet, preferably integral with the second wall 16. Hence, substantially the entire capsule 2 may be manufactured of the flexible sheet, reducing the amount of material required for providing the capsule 2.

5 In the examples the circumferential first wall 14 is substantially cylindrical. It will be appreciated that the capsule according to the invention is not limited to this shape. The circumferential first wall 14 may e.g. be frustoconical, hemispherical, or polygonal, such as hexagonal, octagonal, etc.

 The capsule 2 according to the invention is preferably manufactured
10 by providing a coffee receiving cup 32 comprising the circumferential first wall 14 and the second wall 16. The first wall 14 and the second wall 16 define the inner space 24. Roast and ground coffee starting material, for instance Arabica coffee with a maximum of 30% of Robusta coffee, with a desired particle distribution, a desired moisture content, a desired degree of roast and a
15 desired pouring volume is supplied into the inner space 24 of the coffee receiving cup 32. Then the coffee starting material is compressed by a suitable compression means, for instance with a compression force of approximately 500N. After compression of the coffee in the inner space 24 of the cup, the surface of the compressed coffee facing away from the second wall 16 may be
20 substantially flat. Furthermore, at most a limited amount of coffee particles may be located on a top surface of the circumferential first wall 14 facing away from the second wall 14. In this example of the capsule 2 according to the invention, at most a limited amount of coffee particles, preferably no particles at all, may be located on the extending rim 40. Consequently, an exit filter, for
25 instance a polymeric foil layer 36 can be easily provided and sealed in a tight manner onto the extending rim 40 of the circumferential first wall 14 with a minimized risk of occurrence of unsealed areas between the circumferential first wall 14 and the exit filter 20. This results in a capsule 2 having a substantially flat third wall 20, in other words, the third wall 20 will not
30 substantially extend from the circumferential first wall 14 in a direction

parallel to a central axis A of the capsule 2 (see Fig. 3). Thus, when using such capsule 2 in an apparatus 4 for preparing a beverage, the capsule 2 can be easily placed in the receptacle 6 without getting stuck due to an extending third wall 20. In an alternative embodiment of the invention it is possible that a first part of the coffee starting material is inserted into the inner space 24 of the capsule 2. This first part of the coffee starting material may be compressed by a suitable compression means, for instance with a compression force of approximately 500N. It will be appreciated that the compression means may rotate during compressions or in intervals between subsequent compressions. This has an advantage that oils may substantially decrease at one hand and that DMA's may increase or stay at the same level on the other hand. Subsequently, on top of the compressed first part of the coffee starting material a further part of the amount of roast and ground coffee starting material (as is explained in the foregoing) may be provided in the inner space 24 of the capsule 2. Then the further part of the amount of coffee starting material is compressed by a suitable compression means, for instance with a compression force of approximately 500N, such that the further part is compacted. This provides an easy way of inserting and compressing the coffee starting material in the capsule 2. It is also possible that the method for manufacturing the capsule comprises alternately inserting and compressing more than two parts of the amount of coffee starting material inside the capsule 2.

Fig. 5 shows an example of the capsule 2 according to the invention, wherein the extractable product is compacted into a plurality of, in this example four, tablets 58,60,62,64. In Fig. 5 the tablets 58,60,62,64 are stacked inside the inner space 24. In Fig. 5, each tablet 58,60,62,64 spans substantially the entire cross section of the inner space 24 of the capsule 2. In this example a density, i.e. a degree of compaction, of the tablets 58,60,62,64 is different for each of the tablets. The density of the tablets 58,60,62,64 increases in the direction from the second wall 16 to the third wall 20. This provides the

advantage that the fluid will more easily wet a tablet of lower density than a tablet of higher density, so that each upstream tablet has been properly wetted while the water wets a subsequent downstream tablet. Thus, highly homogeneous wetting of the extractable product is achieved. Although the example shows four stacked tablets, it will be appreciated that any number of tablets may be used.

Fig. 6 shows an example of a capsule 2 comprising a single tablet 66 of compacted extractable product. In the example of Fig. 6 the tablet 66 comprises bores 68 extending into the tablet 66 from the side of the tablet 66 facing the second wall 16 in the direction of the third wall 20. The length of the bores 68 is shorter than the thickness of the tablet 66 in the direction along the bore 68. Thus, the bores 68 do not form shortcut passages for the fluid through the tablet 66, but provide the fluid a passage into the core of the tablet 66. These bores 68 allow a predetermined penetration of the fluid into the tablet. Thus, a preferred wetting of the compacted extractable product may be obtained.

It will be appreciated that the tablet 66 or plurality of tablets 58,60,62,64 may be used in conjunction with any capsule 2 referred to hereinabove. It will also be appreciated that if the extractable product is compacted into the tablet(s) the second wall 16 of the capsule is not strictly required, since the extractable product is not likely to spill from the capsule 2 prior to use.

In the foregoing specification, the invention has been described with reference to specific examples of embodiments of the invention. It will, however, be evident that various modifications and changes may be made therein without departing from the broader spirit and scope of the invention as set forth in the appended claims.

It is for instance possible that the open capsule is contained in an air tight wrapping prior to use to improve shelf-life.

It is for instance possible that the capsule 2 is manufactured from biodegradable materials.

It is for instance possible that the capsule 2 has different dimensions or different shapes.

5 It further may be possible that the coffee is compacted in the inner side of the capsule by using different suitable apparatuses for compacting

The coffee may, in an alternative embodiment of the invention, be compacted before being supplied to the inner space of the capsule. For instance, by first compressing the coffee starting material into a tablet with
10 dimensions corresponding with dimensions of an inner space of a coffee receiving cup of the capsule.

However, other modifications, variations and alternatives are also possible. The specifications, drawings and examples are, accordingly, to be regarded in an illustrative rather than in a restrictive sense.

15 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 features or steps than those listed in a claim.

Furthermore, the words 'a' and 'an' shall not be construed as limited to 'only one', but instead are used to mean 'at least one', and do not exclude a plurality.

20 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.

Claims

1. Capsule for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, for instance roast and ground coffee, comprising a circumferential first wall, a second wall closing the circumferential first wall at a first end, a perforated and/or porous third wall closing the circumferential first wall at a second, open, end opposite the second wall arranged for draining the prepared beverage from the capsule, wherein the first, second and third wall enclose an inner space comprising the extractable product, wherein the extractable product in the inner space has particles falling within a preselected distribution by weight, wherein a 10th percentile of the particle size is 20 – 60 µm, preferably smaller than 40 µm wherein a 50th percentile of the particle size is 400 – 600 µm, preferably 450-550 µm and wherein a 90th percentile of the particle size is 700 – 1000 µm, preferably 825-950µm.
2. Capsule according to claim 1, wherein the extractable product of the capsule has been, at least partly compacted.
3. Capsule according to claim 1 or 2, wherein the capsule comprises 4.0 – 8 grams, preferably 4.9-5.7 grams of roast and ground coffee.
4. Capsule according to claim 1, 2 or 3, wherein the inner space of the capsule has a volume of approximately 10-14 ml, preferably 11.5 – 12.5 ml, more preferably approximately 11.8 ml.
5. Capsule according to any one of the preceding claims, wherein the entire inner space is occupied by the extractable product.

6. Capsule according to any one of the preceding claims 2 - 5, wherein the roast and ground coffee is compacted such that the compacted coffee in the inner space comprises a substantially homogenous density.
- 5 7. Capsule according to any one of the preceding claims, wherein the third wall comprises an exit filter arranged for draining prepared beverage from the capsule, wherein the exit filter for instance is formed by a woven or non-woven fibrous sheet, such as filtering paper, or a polymeric film provided with a plurality of exit openings.
- 10 8. Capsule according to claim 7, wherein the exit filter comprises 80-140 exit openings, wherein an opening diameter is between $0,4\text{mm} \pm 0.05\text{mm}$ and $0.2\text{mm} \pm 0.05\text{mm}$, preferably approximately $0,3\text{mm} \pm 0.05\text{mm}$.
- 15 9. Capsule according to any one of the preceding claims, wherein the first circumferential wall is substantially rigid.
10. Capsule according to at least claim 2 and any one of claims 7-9, wherein the capsule comprises an entrance filter, wherein the entrance filter
20 has a flow resistance that is lower than the flow resistance of the compacted extractable product in combination with the exit filter.
11. Capsule according to any one of the preceding claims, wherein the compacted beverage ingredient is provided in a tablet.
- 25 12. Capsule according to claim 11, wherein the tablet comprises at least one bore extending from the side of the tablet facing the second wall in the direction of the third wall.

13. Capsule according to any one of the preceding claims 11-12, wherein the extractable product is compacted into a plurality of tablets, preferably of mutually different packing density.
- 5 14. Capsule according claim 13, wherein a compaction density increases from the second wall of the capsule towards the third wall of the capsule.
15. Method for manufacturing a capsule according to any one of the preceding claims, wherein the method comprises:
- 10 - providing a coffee receiving cup comprising the circumferential first wall and one of the second and third wall defining an inner space arranged for accommodating roast and ground coffee which has particles falling within a preselected distribution by weight, wherein a 10th percentile of the particle size is 20 – 60 μm , preferably smaller than 40 μm , wherein a 50th percentile of the
- 15 particle size is 400 – 600 μm , preferably 450-550 μm and wherein a 90th percentile of the particle size is 700 – 1000 μm , preferably 825-950 μm ;
- providing an amount of said roast and ground coffee in the inner space of the coffee receiving cup.
- 20 16. Method according to claim 15, wherein the step of providing comprises the step of compacting the amount of roast and ground coffee starting material such that the capsule comprises compacted coffee having the said preselected distribution by weight.
- 25 17. Method according to claim 15 or 16, wherein the method comprises:
- providing a first part of the amount of roast and ground coffee starting material in the inner space;
- compacting said first part such that the said first part is compacted;

- subsequently providing a further part of the amount of roast and ground coffee starting material on top of the compacted first part in the inner space of the capsule;

- compacting the further part.

5

18. Method according to claim 15, 16 or 17, wherein a compacted volume of the roast and ground coffee is substantially similar to a volume of the inner space of the coffee receiving cup.

10 19. Method according to any one of claim 16-17, wherein the roast and ground coffee starting material is compressed with a compressive pressure of substantially 50-800N, preferably of substantially 400-600N, more preferably about 500N.

15 20. Method according to any one of claims 15-19, wherein the inner space of the capsule has a volume of approximately 10-14 ml, preferably 11.5 – 12.5 ml, more preferably approximately 11.8 ml.

20 21. Method according to any one of claims 15-20, wherein the compacted roast and ground coffee has a weight of 4.0 – 8 grams, preferably 4.9-5.7 grams.

22. Method according to any one of claims 15-21, wherein the roast and ground coffee starting material has a pouring volume in the range of 600-680
25 ml per 250 grams of coffee before it is introduced in the capsule.

23. Method according to any one of claims 15-22, wherein the roast and ground coffee starting material has a moisture content of 1.0 – 4.0 %, preferably of 1.5 – 2.2 %, more preferably of approximately 1.5%.

30

24. Method according to any one of claims 16-23, wherein coffee beans for the roast and ground coffee starting material are roasted during approximately 250-1000 seconds, preferably during 450-700 seconds.
- 5 25. Method according to any one of claims 15-24, wherein a degree of roast of the roast and ground coffee starting material is in the range of 30-60.
26. Capsule obtainable by a method according to any one of claims 15-25.
- 10 27. System for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, the system comprising:
an exchangeable capsule according to any one of claims 1-14 and/or 26 and
15 an apparatus comprising:
a fluid dispensing device for supplying an amount of fluid, such as water under a high pressure to the exchangeable capsule,
a receptacle for holding the exchangeable capsule and
an outlet which, in use is in fluid communication with the capsule
20 for draining the prepared beverage from the capsule and supplying the beverage to a container such as a cup.
28. System according to claim 27, wherein the fluid dispensing device is adapted to supply fluid to the exchangeable capsule under a pressure of
25 approximately 4-20 bars, preferably 9-15 bars.
29. Method for preparing a predetermined quantity of beverage suitable for consumption using an extractable product, for instance roast and ground coffee, comprising:

providing an exchangeable capsule according to any one of claims 1-14 and/or 26,

5 providing an apparatus comprising a receptacle for holding the exchangeable capsule, a fluid dispensing device for supplying an amount of fluid, such as water, under a pressure of at least six bars to the exchangeable capsule, and an outlet which, in use is in fluid communication with the capsule for draining the prepared beverage from the capsule and supplying the beverage to a container such as a cup;

arranging the exchangeable capsule in the receptacle;

10 supplying the fluid under pressure to the compacted extractable product for preparing the beverage thereby redistributing relatively small coffee particles in the inner space of the capsule such that said coffee particles are located adjacent the exit filter and together with the exit filter provide a flow restriction of the capsule.

15

30. Method according to claim 29, using a system according to any one of claims 27-28, preferably using a capsule according to any one of claims 1-14 and/or 26.