A beverage preparation capsule containing a beverage preparation ingredient and a functional ingredient, wherein at least a portion of an inside surface of said capsule is coated with a water-dispersible coating containing said functional ingredient. Suitably, the functional ingredient comprises a flavonoid, such as a cocoa polyphenol extract. Suitably, the coating comprises the functional ingredients and a film-forming polymer. The coating is preferably located downstream of the beverage preparation ingredient inside the capsule.
BEVERAGE PREPARATION CAPSULES FOR DELIVERY OF FUNCTIONAL INGREDIENTS

[0001] The present invention relates to beverage preparation capsules for the delivery of beverages containing functional ingredients such as added flavonoids, vitamins, antioxidants or minerals, to a beverage. The invention relates in particular to such capsules for use in single-serve beverage dispensing machines.

[0002] A number of beverage making systems are known in which a single serving of the beverage is made by inserting a capsule containing a particular beverage making ingredient, such as ground coffee, into a beverage making station of a beverage making apparatus. The apparatus then injects water into the capsule, where the beverage making ingredient dissolves in, or infuses into, the water to form the beverage. The beverage flows out of the capsule through a suitable outlet, which may be simply an opening or perforation in the capsule, or it may comprise an outlet tube that pierces an outlet region of the capsule. The capsule may incorporate a filter to prevent passage of solid components such as coffee grounds out of the capsule. Beverage making systems of this general type are described for example in WO 94/01344, EP-A-0512468 and EP-A-0468079 (all Nestle), in U.S. Pat. No. 5,840,189 (Keurig), in EP-A-0272922 (Kenco), in EP-A-0821906 (Sara Lee) and in EP-A-0179641 and WO 02/19875 (Mars).

[0003] The above capsules have been adapted for the preparation of flavoured beverages, for example nut-flavored or vanilla-flavored coffees by the addition of flavouring agents to the beverage making ingredient.

[0004] It is also known to add functional ingredients to single-serve beverage preparation packages. For example, JP-A-12266841 describes a barley-tea bag containing catechin-enriched green tea.

[0005] The present inventors have found that the addition of functional ingredients to the beverage preparation ingredient in a beverage preparation capsule has certain disadvantages. In particular, incomplete extraction of the functional ingredient from the mixture results in variable dosage of the functional ingredient into the beverage, and to wastage of the relatively expensive functional ingredient. It is thought that this incomplete extraction may be due to adsorption or reaction of the functional ingredient with the beverage ingredient and/or with the filter material inside the capsule.

[0006] In a first aspect, the present invention provides a beverage preparation capsule containing a beverage preparation ingredient and a functional ingredient, wherein at least a portion of an inside surface of said capsule is coated with a water-dispersible coating containing the functional ingredient.

[0007] The provision of the functional ingredient in a water dispersible coating on an inside surface of the capsule allows the functional ingredient to be dispersed into the beverage only when water is injected into the capsule in use. The functional ingredient is kept substantially or completely separate from the beverage ingredient before use. Moreover, it is easy to apply a controlled dose of the functional ingredient as a coating on the inside of the capsule during manufacture. Suitably, at least 50%, more suitably at least about 90%, and most suitably all of the added functional ingredient is present in the coating.

[0008] The present invention provides a convenient, efficient and cost-effective means to add functional ingredients to a beverage. Compared with other systems, in which relatively large amounts of functional ingredient may need to be mixed with a beverage preparation ingredient in order to achieve a desired functional effect or sufficient bioavailability, the present invention can contain only a minimal amount of functional ingredient while still achieving the desired functional effect and/or bioavailability. Functional ingredients may be expensive and may contribute undesired taste and/or appearance to a beverage product. By maximising the functional effect and/or bioavailability from a given amount of functional ingredient, only a relatively small amount of functional ingredient is needed in the present invention, such that any undesired taste and/or appearance can be minimised and cost reduced.

[0009] Suitably, the capsule further comprises a filter element that divides an interior space of the capsule into an upstream region containing the beverage preparation ingredient and a downstream region, and the coating containing the functional ingredient is located on an internal surface of the downstream region. In use, the functional ingredient is dispersed into the beverage after the liquid has passed through the filter. This eliminates problems of adsorption of the functional ingredient on a residue of the beverage preparation ingredient (e.g. coffee grounds), or adsorption of the functional ingredient onto the filter.

[0010] Suitably, the capsule may be closed with a releasable seal, such that both the beverage preparation ingredient and the coating containing the functional ingredient are located within the capsule and protected from the environment outside the capsule. Preferably, the capsule comprises a filter element that divides an interior space of the capsule into an upstream region containing the beverage preparation ingredient and a downstream region containing the functional ingredient, wherein the coating containing the functional ingredient is applied to at least a part of the inside surface of the downstream region of the capsule, but upstream from a releasably sealed outlet region of the capsule.

[0011] The beverage preparation capsule may be based on any of the capsules currently used for preparation of beverages by injection of water into the capsule. Suitably, the capsule is a single-serve capsule that contains sufficient beverage preparation ingredients for the preparation of a single portion of beverage, i.e. from about 25 to about 500 ml, preferably from about 100 ml to about 250 ml of beverage. For example, the capsule may contain from about 2 g to about 25 g of ground coffee or from about 1 g to about 9 g of leaf tea.

[0012] The capsule is suitably substantially impermeable to oxygen and moisture before use in order to preserve the freshness of the beverage ingredient. Typically, each capsule comprises a body formed from plastics sheet (e.g. thermoformed or injection molded sheet) and/or from flexible film material. The sheet or flexible film material will usually be a laminate comprising two or more of the following layers: a thermoplastic sealant layer for bonding the sheet to other members of the package; a substantially gas-impermeable barrier layer, which may be a metal film such as aluminium film; adhesion layers to improve adhesion between other layers of the laminate; structural layers, for example to provide puncture resistance; and/or a printing substrate layer. The structural layers could be made of polycylcins, polyester, nylon, or other polymers as is well known in the art.
In one group of embodiments, the capsule may be a sachet having a body formed substantially or completely from flexible film material. For example, it may comprise two similar or identical sheets of flexible film material bonded together in face-to-face relationship around a margin to form a film sachet. In another group of embodiments the capsules may comprise a first, relatively rigid sheet that has been formed, e.g., by thermo-forming, into a cup or bowl shape, and a second sheet that is bonded across the rim to form the capsule body. For example, the first sheet may be a relatively stiff thermoplastic sheet that has been thermo- formed into a cup or bowl shape with a flanged rim, and the second sheet is a flat sheet, which may be of flexible film material, that is bonded across the flanged rim. Suitable capsule embodiments are described for example in the references listed above.

The capsule may further comprise a filter element, for example a layer of filter sheet material, for preventing escape of the beverage preparation ingredient in use. The filter sheet may be located inside the capsule dividing the interior of the capsule body into an upstream region containing the beverage preparation ingredient and a downstream region through which the beverage flows to escape from the capsule. The downstream region may include various features such as a tubular flow path or eductor for the beverage, a beverage conditioning chamber, or a jet-forming orifice, for example as known in the art. Typically, the filter element is similar to the filter elements currently provided in existing beverage capsule formats.

In embodiments, the capsule comprises a water inlet such as an inlet nozzle. In other embodiments, there is no inlet nozzle and water is injected by piercing the capsule with an injector tube of a beverage making machine. Similarly, the capsule may comprise an outlet for the beverage. Alternatively, the outlet may be formed in use by piercing the capsule with an outlet tube, or by opening a heat-resealable seal on the capsule. In any event, the capsule will have an inlet region where water is injected in use, an outlet region from which the beverage escapes from the capsule in use, and a liquid flow path within the capsule that passes through the beverage preparation ingredient.

The coating containing the functional ingredient is adhered to an internal surface of the capsule at a location such that the coating is exposed to the beverage produced in the capsule in use, to dissolve the coating into the beverage. Suitably, the coating is located downstream of any filter element in the capsule so as to minimise exposure of the functional ingredient to the beverage ingredient and/or the filter. Suitably, the area of the coating is from about 0.5 cm² to about 20 cm², for example from about 1 cm² to about 10 cm². The basis weight of the coating is suitably from about 1 g/m² to about 2 kg/m², for example from about 50 g/m² to about 500 g/m². The total weight of the coating is suitably from about 1 mg to about 1 g, for example from about 10 mg to about 500 mg, typically from about 50 mg to about 300 mg.

The functional ingredient may for example be selected from the group consisting of flavonoids, vitamins, minerals, antioxidants, stimulants, flavouring agents, sweeteners, colouring agents and bitterness blocking compounds.

The total amount of each functional ingredient in the coating will depend on the ingredient. Suitably, it is from about 1% to about 100%, for example about 5% to about 50%, typically about 10% to about 30% of the recommended adult daily intake of the functional ingredient. Suitable ranges for certain functional ingredients are defined below.

Most suitably the functional ingredient comprises, or consists essentially of, one or more flavonoids. Flavonoids and their polymers constitute a class of food constituents, which alter metabolic processes and have a positive impact on health. Flavonoids have thus attracted considerable interest as food components or food additives.

Flavonoids are a subclass of polyphenols. They generally consist of two aromatic rings, each containing at least one hydroxyl group. The two rings are connected through a three-carbon "bridge" which forms part of a six-membered heterocyclic ring. The flavonoids are further divided into subclasses based on the connection of an aromatic ring to the heterocyclic ring, as well as the oxidation state and functional groups of the heterocyclic ring. Within each subclass, individual compounds are characterized by specific hydroxylation and conjugation patterns.

Typically, flavonoids in foods have the following general structure showing three rings (A, B and C) and numbering pattern:

The substituents R₃ through R₄ may represent hydrogen or a variety of groups such as hydroxyl groups, oxo groups and C₁ to C₄ linear or branched alkyl groups. For most food flavonoids R₅ and R₆ represent a hydrogen atom while R₇ represents a hydroxy group. The C-ring may also be unsaturated and contain further functional groups. The link between the B and the C ring may be in 2 or 3 position.

For the purpose of this invention, the flavonoid compound may comprise one or more of a flavonol (for example quercetin, rutin, morin, hesperidin, isorhamnetin, kaempferol, myricitin), a flavone (for example aacetin, apigenin, luteolin), an isoflavone (for example genistein, glycitein, biochanin A, formononetin, daidzein), a flavanol (for example catechins, galloacatechin, epicatechins, polymers thereof, procyanidins), a flavane (for example taxifolin, eriodictyol, hesperitin, narigenin), a dihydroflavonol, an anthocyanin and/or an anthocyanidin (for example cyanidin, delphinidin, malvidin, pelargonidin, petunidin, peonidin). It will be appreciated that polyphenols are also encompassed within the term "flavonoid" for the present application. Further examples of flavonoids include daidzein, ginkgetin, tangeritin, kaempferol, myricetin, fisetin, isorhamnetin, naringenin, eriodictyol, thearubigins, tamarixetin, malvidin, peonidin, petunidin, and/or delphinidin.

As used herein the term "catechins" is used as a generic term for catechin, galloacatechin, catechin gallate, galloacatechin gallate, epicatechin, epigallocatechin, epicatechin gallate, epigallocatechin gallate, and mixtures thereof.

The flavonoid additive for use in the present invention can be pure flavonoid starting materials or a variety of
flavonoid-containing materials such as plant parts, plant extracts and the like. For instance, one may use green tea extracts with high levels of catechins (e.g., green tea extract from Naturex, France, standardized to 95% polyphenols, 75% catechins, <0.5% caffeine, >40% epigallocatechin gallate); grape seed or skin extracts (e.g., exGrape grape seed polyphenol powder OPC 40#8448/84481 supplied by Breko, Germany with 40% of oligomeric procyanidin; grape polyphenol powder P80, white, 88.34%; supplied by Breko, Germany with 80% polyphenols). Also suitable are addition products of flavonoids with saccharides, as described in EP-A-1856988.

[0026] Especially suitable flavonoids for use in the present invention include cocoa polyphenols. Consumption of cocoa polyphenols (CPs) in cocoa products provides significant health benefits. Cocoa polyphenols have been shown to have beneficial effects on the processes believed to be involved in the development of atherosclerosis and cardiovascular disease. Cocoa polyphenols inhibit LDL oxidation, enhance nitric oxide/nitric oxide synthase (NO/NOS) activity, and inhibit cyclooxygenase (COX) and lipooxygenase (LOX) activity; these effects are reported in WO 97/36497. Cocoa polyphenols can also be used to treat or prevent conditions which are known to be affected by the administration of non-steroidal anti-inflammatory drugs, for example, aspirin.

[0027] The term “cocoa polyphenols” refers to the polyphenolic compounds, including proanthocyanidins, more particularly procyanidins, present in cocoa beans, cocoa nibs, and most cocoa ingredients prepared from cocoa beans or cocoa nibs. The term “procyanidin” refers to naturally occurring or synthetically derived oligomers of catechin and/or epicatechin. Any reference to “cocoa polyphenols” should be understood to include the flavan-3-ol monomers catechin and epicatechin. The monomers include (+)-catechin and (-)-epicatechin and their respective epimers (e.g., (+)-epicatechin and (-)-epicatechin) and derivatives thereof. The monomers have the formula “A” and the oligomers have the formula “An” where n in an integer from 2 to 18 and higher. “A” has the formula:

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\begin{align*}
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where R is 3-(alpha)-OH, 3-(beta)-OH, 3-(alpha)-O-saccharide, 3-(beta)-O-saccharide, 3-(alpha)-O-C(O)—R1; or 3-(beta)-O—C(O)—R1; where R1 may be an aryl or heteroaryl moiety optionally substituted with at least one hydroxy group; and salts, derivatives, and oxidation products thereof. Advantageously, the saccharide moiety is derived from the group consisting of glucose, xylose, rhamnose, and arabinose. The saccharide moiety and any or all of R, X, Y, and Z may optionally be substituted at any position with a phenolic moiety via an ester bond. The phenolic moiety is selected from the group consisting of caffeic, cinnamic, coumaric, fufural, gallic, hydroxybenzoic, and sinapic acids.

[0028] Underfermented and unfermented raw cocoa materials contain substantial amounts of cocoa polyphenols compared to fermented cocoa materials. Fermentation and drying bring about complex changes in the cocoa bean, most notably, the formation of the components required for the development of the characteristic flavor and color of cocoa. Fermentation, however, also significantly decreases the concentrations of the polyphenolic compounds in the fermented cocoa beans relative to the concentrations of polyphenolic compounds in the unfermented or underfermented cocoa beans. Traditional cocoa bean processing, including such steps as roasting or defatting of the cocoa beans, also reduces the cocoa polyphenol concentration in the cocoa powder or chocolate liquors produced thereby. Moreover, these processes reduce the concentrations of higher oligomeric polyphenols (i.e., oligomers 5-12) more rapidly than the lower oligomers (i.e., oligomers 2-4).

[0029] Cocoa extracts containing polyphenols can also be prepared by solvent extracting partially or fully defatted cocoa solids prepared from unfermented and/or underfermented cocoa beans or cocoa nibs. See U.S. Pat. No. 6,015,913 and U.S. Pat. No. 6,312,753.

[0030] Suitably, the flavonoid (including cocoa flavonoid) is present in the finished beverage in an amount of at least 0.06% by weight of the beverage, preferably at least 0.07% for example at least 0.08%. The amount of flavonoid should not be too high, however, otherwise the taste and/or appearance of the beverage may be impaired. Therefore it is preferred that the finished beverage comprises flavonoids in an amount of less than 1% by weight of the beverage, preferably less than 0.5% and most suitably less than 0.2%.

The amount of flavonoids can be determined by HPLC using the method described in US-A-2008020869. For a typical single-serve capsule this implies that the capsule contains from about 20 mg to about 1 g, more suitably from about 50 mg to about 500 mg, most suitably from about 100 mg to about 300 mg of the added flavonoids (i.e., excluding flavonoids inherently present in the beverage preparation ingredient). Suitably, the added flavonoids are substantially completely contained in the coating.

[0031] The functional ingredients may additionally or alternatively comprise one or more antioxidants other than flavonoids. Such antioxidants may also be useful as oxygen scavengers to maintain the freshness of the beverage ingredient inside the pack before use. Suitably, the coating contains from about 1 mg to about 100 mg, for example from about 5 mg to about 20 mg of such other antioxidants in the coating.

[0032] The functional ingredient may additionally or alternatively comprise ginseng, for example belonging to the genus Panax of the family Araliaceae and/or an extract of ginseng, such as a ginsenoside (also termed panaxoside), preferably dammarane ((5S,8R,9R,10S,13R,14R,17R)-4,4,8,10,14-pentamethyl-17-[(2R)-6-methylheptan-2-yl]-2,3,5,
6,7,9,11,12,13,15,16,17-dodechydro-1H-cyclopent[a]phenanthrene), or protopanaxadiol ((3S,5R, 8R,9R,10R, 12R, 13R,14R, ... description of Sucralose; and 0041 E. protein based sweeteners such as thaumatococcus danielli (Thaumatin I and II).

[0033] The functional ingredients may additionally or alternatively comprise a weight management active. Suitable actives include biotin, pantothenic acid (vitamin B5), vitamin B6, nicin, magnesium, yerba mate extract, guarana extract, hydroxycitric acid and mixtures thereof. Suitably, the coating contains from about 1 mg to about 100 mg, for example from about 5 mg to about 20 mg of such ingredients.

[0034] The functional ingredients may additionally or alternatively comprise vitamins and/or minerals. The preferred vitamins are for example, vitamin A, vitamin C, vitamin D, vitamin E, vitamin K, and their derivatives and/or pro-vitamins. Preferred vitamins also include B vitamins such as, for example, biotin, folic acid, nicin, niacinamide, pantothenate, pyridoxine hydrochloride, riboflavin, thiamin hydrochloride, and the like. Suitably, the coating contains from about 1 mg to about 100 mg, for example from about 5 mg to about 20 mg of vitamins and/or pro-vitamins. The preferred minerals include but are not limited to bromine, calcium, chromium, copper, iodine, iron, magnesium, manganese, phosphates, phosphorus, potassium, selenium, sodium, sulfur, and zinc. Suitably, the coating contains from about 1 mg to about 100 mg, for example from about 5 mg to about 20 mg of such ingredients.

[0035] Alternatively or additionally, the functional ingredients include, for example, amino acids such as arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, valine, alanine, aspartic acid, glutamic acid, glutamine, glycine, serine, tyrosine, creatine, and the like. Suitably, the coating contains from about 1 mg to about 100 mg, for example from about 5 mg to about 20 mg of such ingredients.

[0036] Alternatively or additionally, the functional ingredients include sweeteners. Suitable sweeteners include, but are not limited to:

[0037] A. water-soluble sweetening agents such as monelina, steviosides, and glycyrrhizin;

[0038] B. water-soluble artificial sweeteners such as the soluble saccharin salts, i.e., sodium or calcium saccharin salts, cyclamate salts, the sodium, ammonium or calcium salt of 3,4-dihydro-6-methyl-1,2,3-oxathiazine-4-one-2,2-dioxide, the potassium salt of 3,4-dihydro-6-methyl-1,2,3-oxathiazine-4-one-2,2-dioxide (acesulfame-K), the free acid form of saccharin, and the like;

[0039] C. dipeptide based sweeteners, such as L-aspartic acid derived sweeteners, such as L-aspar-L-phenylalanine methyl ester (aspartame) and materials described in U.S. Pat. No. 3,492, 131, L-aspa-aspar-N-(2,2,4,4-tetramethyl-3-thietyl)-D-alaninamide hydrate, methyl esters of L-aspar-L-phenylglycerin and L-aspar-L-2,5, dihydrophenylglycine, L-aspar-L-2,5, dihydro-L-phenylalanine, L-aspar-L-(1-cyclohexeyen)-alanine, and the like;

[0040] D. water-soluble sweeteners derived from naturally occurring water-soluble sweeteners, such as a chlorinated derivative of ordinary sugar (sucrose), known, for example, under the product description of sucralose; and

[0041] E. protein based sweeteners such as thaumatococcus danielli (Thaumatin I and II).

[0042] In general, an effective amount of auxiliary sweetener is utilized to provide the level of sweetness desired for a particular beverage, and this amount will vary with the sweetener selected. The coating suitably contains from about 1 mg to about 1 g of total sweeteners, for example from about 5 mg to about 500 mg of total sweeteners, typically from about 10 mg to about 300 mg of total sweeteners.

[0043] Alternatively or additionally, the functional ingredients include natural and artificial flavorings such as synthetic flavor oils and flavoring aromatics, and/or oils, oleo resins and extracts derived from plants, leaves, flowers, fruits and so forth, and combinations thereof. Representative flavorings include, but are not limited to, artificial vanilla, cinnamon derivatives, peppermint oil, clove oil, oil of nutmeg, oil of sage, and oil of bitter almonds, chocolate, coffee, cocoa and citrus oil, including lemon, orange, grape, lime and grapefruit and fruit essences including apple, pear, peach, strawberry, raspberry, cherry, plum, pineaple, apricot, whether employed individually or in admixture. These flavorings can be used individually or in admixture.

[0044] The amount of flavoring employed in the coating may be normally a matter of preference subject to such factors as flavor type, individual flavor, and strength desired. Thus, the amount may be varied in order to obtain the result desired in the final product. Such variations are within the capabilities of those skilled in the art without the need for undue experimentation. The coating suitably contains from about 1 mg to about 1 g of total flavorings (other than sweetener), for example from about 5 mg to about 500 mg, typically from about 10 mg to about 300 mg.

[0045] Suitably, the coating comprises the functional ingredient dispersed in a film-forming matrix. The functional ingredient may be dispersed as a solution (e.g., solid solution) in the matrix, or as a dispersion in the film-forming matrix of solid particles of the functional ingredient, or as a dispersion in the film-forming matrix of microcapsules containing the functional ingredient.

[0046] The film-forming matrix confers adhesion to the inside wall of the capsule, dilutes the functional ingredient making precise dosage easier, and protects the functional ingredient prior to use of the capsule. The matrix must be water-dispersible, and preferably soluble. It should be formed from food-acceptable (GRAS) materials.

[0047] The film-forming matrix suitably comprises at least one edible film-forming polymer and may further comprise water, preservatives, plasticizing agents, emulsifying agents, and buffers.

[0048] The edible film-forming polymer used in the coating can be any suitable film-forming polymer including, but not limited to, alginites, pullulan, hydrocolloids, ss-glucan, maltodextrin, celluloses, including hydroxypropylmethyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, carboxymethyl cellulose, methylcellulose, hydroxyethylcellulose, hydroxyethylcellulose, polyvinyl pyrrolidone, polyvinyl alcohol, polyethylene glycol, hydroxypropyl ethyl cellulose, cellulose acetate phthalate, hydroxypropyl methyl cellulose phthalate, natural gums, such as locust bean gum, carrageenan gum, xanthan gum, tragacanth gum, guar gum, acacia gum, arabic gum, karaya, gutta, tamarind gum, polyacrylic acid, methylmethacrylate copolymer, carboxyvinyl polymer, amylose, high amylose starch, hydroxypropylated high amylose starch, dextrin, pectin, chitin, chitosan, levan, elsinan, collagen, gelatin, zein, gluten, soy protein
isolate, whey protein isolate, casein, and mixtures thereof. Most suitably, the film-forming polymer comprises or consists essentially of a gum.

[0049] The edible film-forming polymer used in the films may also include water dispersible synthetic polymers, copolymers, block polymers, including, but not limited to, poly (glycolic acid) (PGA), poly (lactic acid) (PLA), polydioxanones, polyoxyalates, poly (alpha-esters), polyhydrides, polyacetalates, polycaprolactones, poly (orthoesters), polyamino acids, polynamincarbonates, polyurethanes, polycarbonates, polyamides, poly (alkyl cyanoacrylates), stereopolymers of L- and D-lactic acid, copolymers of bis (p-carboxyphenoxy) propane acid and sebacic acid, sebacic acid copolymers, copolymers of caprolactone, poly (lactic acid)/poly (glycolic acid)polyethylene glycol copolymers, copolymers of polyurethane and poly (lactic acid), copolymers of polyurethane and poly (lactic acid), copolymers of alpha-amino acids, copolymers of alpha-aminic acids and caproic acid, copolymers of alpha.-benzyl glutamate and polyethylene glycol, copolymers of sucrose and poly (glycols), polyphosphazene, polyhydroxy-alkanoates, and any combinations thereof.

[0050] Suitably, the edible film-forming polymer is present in amounts ranging from about 10 to about 99 wt %, about 30 to about 80 wt %, or from about 45 to about 70 wt %, or from about 50 to about 65 wt % of the coating. Suitably, the coating contains less than about 20 wt % of water, for example less than about 15 wt % of water, typically from about 1 wt % to about 10 wt % of water. Suitably, the coating contains from about 1 wt % to about 90 wt %, more suitably about 2 wt % to about 50 wt %, for example about 5 wt % to about 25 wt % of the functional ingredient. The above percentages are by weight based on the weight of the coating.

[0051] The coatings may include a preservative. The preservative may be added in amounts from about 0.001 to about 5 wt %, or from about 0.01 to about 1 wt % of the coating. In one embodiment, preservatives include sodium benzoate and potassium sorbate.

[0052] The coating may also include a plasticiser. Plasticisers include polyhydric alcohols such as such as sorbitol, glycerin, polyethylene glycol, propylene glycol, hydrogenated starch hydrolysates, corn syrups, as well as monoacetin, diacetin, triacetin, maltitol and mannitol. The plasticiser may be added in wide range of amounts, including, but not limited to, from about 1 to about 20 wt %, or from about 5 to about 15 wt % of the coating.

[0053] The beverage preparation capsules according to the invention can be made by simple modification of existing methods, whereby the coating containing the functional ingredient is applied to at least a region of the inside surface of the capsule at any stage prior to sealing of the capsule. Suitably, the coating is applied as a solution or dispersion in a suitable solvent, such as water, followed by drying. The solution or dispersion may be applied by brushing, spraying or printing (e.g. transfer printing, intaglio printing). In other embodiments, the coating may be melted without addition of a solvent and then applied as above. In yet other embodiments, the coating may be formed by adhering a solid film of the coating material to the inside surface using a suitable food-appropriate adhesive or by heat bonding or ultrasonic bonding.

[0054] In a further aspect, the present invention provides a method of preparing a beverage, comprising the step of passing an aqueous liquid through a beverage preparation capsule according to the present invention. The aqueous liquid is preferably water, for example at a temperature of 85°C to 99°C. The method may be performed in the beverage preparation apparatus already known for use with existing capsule formats, for example as described in the patent references listed above, without modification of the apparatus. The water may suitably be injected at a pressure of 0.5 to 1.5 bar gauge for filler-type coffee, and at higher pressures such as 5-20 bar gauge for espresso-type coffee, depending on the system.

[0055] Specific embodiments of the present invention will now be described further, by way of example, with reference to the accompanying drawings, in which:

[0056] FIG. 1 shows an external view of a FLAVIA® type capsule modified according to the invention;

[0057] FIG. 2 shows a longitudinal cross-section on A-A of the capsule of FIG. 1;

[0058] FIG. 3 shows a longitudinal cross-section on A-A of the capsule of FIG. 1 in use to prepare a beverage;

[0059] FIG. 4 shows an elevation view, partially cut away, of a second beverage preparation capsule according to the present invention;

[0060] FIG. 5 shows a side elevation partially cut away of a third beverage preparation capsule according to the present invention;

[0061] FIG. 6 shows the capsule of FIG. 5 in use to prepare a beverage.


[0063] The capsule 1 according to this embodiment of the invention is a single-serve capsule generally similar to the sachet described in EP-A-0179641. It comprises two flexible laminate sheets 2,3 forming a sachet body. Each laminate sheet comprises an inner thermoplastic sealing film. The front and back sheets 2,3 are bonded together in face-to-face relation along edge seams 4, 5, top seam 6 and bottom seam 7. At least a central region of the bottom seam 7 is bonded with a peelable adhesive that can be released by the action of heat and/or pressure of liquid inside the capsule, and/or with the assistance of external heating from the beverage preparation apparatus. A nozzle 8 is inserted into the top seam 6 of the capsule in air-tight fashion. The nozzle 8 has a central cylindrical bore 9 sealed at the top by membrane 10. A flange 11 on the nozzle enables the capsule to be gripped by a clamp.

[0064] Referring to FIG. 2, within the capsule 1 is a folded web of filter material 12. Top edges 13 of the filter sheet are bonded to the inside walls of the front and back sheets 2,3 to divide the interior of the capsule into upstream and downstream regions. The web of filter material 12 supports a beverage preparation ingredient 14, such as ground coffee or leaf tea, in the upstream region. Suitably, the capsule contains about 15 g of ground coffee. The sheet of web material 12 is folded to form a W in cross-section. The capsule provides an oxygen and moisture-impermeable enclosure for the ingredient until it is used.

[0065] Water dispersible coatings 16, 17 containing functional ingredients are applied to regions of the inside surfaces of the front and back sheets 2,3 in the downstream region below the filter 12. In this particular embodiment, the
coatings 16,17 comprise approximately 100 mg of cocoa polyphenol extract dispersed in an edible gum base. [0066] In use, the capsule 1 is introduced into a FLAVIA® dispensing machine, which comprises a clamp to grip the nozzle under the flange 11, and a hollow injector tube with a mechanism to insert the hollow injector tube into the nozzle bore 9, thereby piercing the freshness barrier 10. The dispensing machine further comprises a source of hot water and a pump to inject the hot water through the injector tube into the capsule at about 0.5 bar gauge pressure. Upon introduction of the hot water through the injector tube and the nozzle bore, the beverage preparation ingredient 14 contained in the capsule 100 is mixed with the hot water and a beverage is brewed. The liquid pressure causes the apex of the W-folded filter sheet 12 to evert to provide a downwardly convex filter bed as shown in FIG. 3. Further details and advantages of the evertable filter webs may be found in EP-A-0179641. The bottom seam 7 of the capsule 1 opens under the effect of heat and liquid pressure inside the capsule (and optionally also external heating), and the beverage passes through the filter web 12 and the open bottom of the capsule and is collected in a receptacle located at a receptacle station situated directly below the capsule. The hot beverage dissolves the coatings 16,17 to release the functional ingredients into the beverage as it flows through the downstream part of the capsule. [0067] The capsules and method provide beverages of superior quality, and furthermore provide the advantage of avoiding cross-contamination of the beverage preparation apparatus by successive beverages because the beverage does not contact any part of the apparatus after preparation. The functional ingredients are protected in the coatings against degradation prior to use of the capsule, and are then released completely into the beverage by dissolution of the coatings to provide a predictable dose of the functional ingredients in the beverage. [0068] Referring to FIG. 4, the capsule 20 according to this embodiment of the invention is a modification of the capsule described above. It comprises two flexible laminate sheets. Each laminate sheet comprises an inner thermoplastic sealing film. The front and back sheets are bonded together along edge seams 21, top seam 22 and bottom seam 23. The bonding of the top and side edges is suitably by heat or ultrasonic bonding, to form a permanent weld between the sheets. At least a central region of the bottom seam 23 is bonded with a peelable adhesive that can be released by the action of heat and or/pressure of liquid inside the capsule, and/or assisted by heat applied from outside the capsule. A nozzle 24 is inserted into the top seam 22 of the capsule. The nozzle 24 has a central cylindrical bore sealed at the top by membrane 25. [0069] A further transverse permanently bonded seam 26 between the front and back sheets extends across the capsule intermediate the top and bottom transverse seals to divide the capsule into an upstream beverage ingredient chamber 27 and a downstream beverage collection/conditioning chamber 28. The intermediate seam 26 does not extend completely across the capsule. An unbonded gap is left in the intermediate seam to provide the outlet channel from the beverage preparation chamber 27. This gap is filled by a filtration element 29 formed by rolling up and flattening a sheet of filter sheet material. The filtration element 29 is bonded to the front and back sheets in the gap. The filtration element projects into the beverage preparation chamber 27 so as to increase the area available for filtration and to prevent filter blocking in use. [0070] Substantially filling the ingredient chamber 27 of the capsule there is about 15 g of ground roasted coffee. The capsule provides an oxygen and moisture-impermeable enclosure for the coffee until the capsule is used. [0071] Water dispersible coatings 30 containing functional ingredients are applied to regions of the inside surfaces of the front and back sheets downstream of the filter plug in the beverage collection/conditioning chamber 28. In this particular embodiment, the coatings comprise approximately 100 mg of cocoa polyphenol extract dispersed in an edible gum base. [0072] These capsules are intended in particular for the preparation of espresso-type coffee by brewing the coffee inside the capsule 20 under pressure, for example by injection of water at 5 to 20 bar gauge pressure. In use, at least the ingredient compartment of the capsule is normally substantially completely enclosed by, and in contact with, the inner surfaces of a clamp cavity. The cavity supports the beverage brewing capsule enclosed within the cavity, thereby enabling easy hydrostatic pressures to be developed inside the capsule without bursting the capsule. The clamp is further adapted to apply a pinch force to outlet of the beverage compartment and the filter plug so as to achieve an optimum combination of beverage escape rate from the capsule and back pressure to optimize beverage quality and brewing speed. The beverage passing through the outlet chamber dissolves the coatings to release the functional ingredients into the beverage. [0073] Referring to FIGS. 5 and 6, the beverage brewing capsule 40 according to this embodiment is of a second conventional type as described for example in U.S. Pat. No. 5,840,189, U.S. Pat. No. 5,325,765 and WO-A-2005026018. The capsule is in the form of a thermoformed plastic cup portion 42 having a flange 44 projecting circumferentially around the lip of the cup 42. A circular cover sheet 43 of thermoplastic sheet or flexible film is sealed to the flange 44 over the top of the cup 42 to provide an air-tight enclosure. [0074] A self-supporting cup-shaped wettable filter element 45 is disposed in the capsule. The top rim of the filter element is and is permanently sealed between the flange 44 and the cover sheet 43. The filter element subdivides the capsule into upstream and downstream chambers: an upstream chamber for storing the beverage making ingredient 46 such as ground coffee, and a downstream empty chamber for accessing the beverage after the beverage outflow from the filter has been made by combining a liquid with the ingredient. [0075] Water dispersible coatings 47,48 containing functional ingredients are applied to the inside surface of the downstream region of the thermoformed cup 42. In this particular embodiment, the coatings comprise approximately 100 mg of cocoa polyphenol extract dispersed in an edible gum base. [0076] In use, the capsule 40 is held in a clamp in a suitable beverage preparation apparatus. The clamp is equipped with an injector tube or other piercing means to pierce the cover sheet 43. Hot water is injected into the capsule to prepare coffee inside the capsule. The clamp further comprises a second injector tube or other piercing means to pierce the base of the cup 42, from where the coffee flows to a suitable receptacle. In certain embodiments, both the liquid injection and the escape of the coffee take place
through respective injector and outlet tubes pierced through the cover 43. In any case, the beverage after it has passed through the filter contacts the coatings 47, 48, which dissolve in the beverage to release the functional ingredient into the beverage.

[0077] The above embodiments have been described by way of example only. Many other embodiments falling within the scope of the accompanying claims will be apparent to the skilled reader.

1. A beverage preparation capsule containing a beverage preparation ingredient and a functional ingredient, wherein the capsule is substantially impermeable to oxygen and moisture before use, and wherein at least a portion of an inside surface of said capsule is coated with a water-dispersible coating containing said functional ingredient.

2. A beverage preparation capsule according to claim 1, further comprising a filter element that divides an interior volume of said capsule into an upstream region containing said beverage preparation ingredient and a downstream region, and said coating is located on an internal surface of said downstream region.

3. A beverage preparation capsule according to claim 1, wherein said capsule comprises front and back sheets of flexible film material bonded together in face-to-face relation.

4. A beverage preparation capsule according to claim 3, further comprising a water inlet nozzle in a top edge of said capsule, wherein said front and back sheets are bonded together in a bottom edge of said capsule by means of a seal that is releasable by heat and pressure during preparation of a beverage inside the capsule to provide an outlet through said bottom edge for said beverage.

5. A beverage preparation capsule according to claim 1, wherein said capsule comprises a base portion having a bottom and side walls, and a flexible film lid bonded across said lip to seal said capsule.

6. A beverage preparation capsule according to claim 5, wherein said base portion is substantially frustoconical, and said capsule further comprises a cup-shaped filter element having a top edge circumferentially bonded to an upper part of the base portion to divide an interior volume of the capsule into an upstream region containing the beverage preparation ingredient and a downstream region.

7. A beverage preparation capsule according to claim 1, wherein said functional ingredient is selected from flavonoids, vitamins, minerals, antioxidants, flavouring agents, sweeteners, and mixtures thereof.

8. A beverage preparation capsule according to claim 7, wherein the functional ingredient comprises one or more flavonoids.

9. A beverage preparation capsule according to claim 8, wherein the one or more flavonoids comprises a cocoa polyphenol extract.

10. A beverage preparation capsule according to claim 1, wherein the water dispersible coating comprises a film forming polymer in which said functional ingredient is dispersed.

11. A beverage preparation capsule according to claim 10, wherein said film forming polymer is selected from an alginate, a gum, a starch derivative or a cellulose derivative and mixtures thereof.

12. A beverage preparation capsule according to claim 10, wherein said film forming polymer is selected from pullulan, hydrocolloids, ss-glucan, maltodextrin, hydroxypropylmethyl cellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, carboxymethyl cellulose, methylcellulose, hydroxyethyl cellulose, hydroxypropyl cellulose, polyvinyl pyrrolidone, polyvinyl alcohol, polyethylene glycol, hydroxypropyl ethyl cellulose, cellulose acetate phthalate, hydroxypropyl methyl cellulose phthalate, locust bean gum, carrageenan gum, xanthan gum, tragacanth gum, guar gum, acacia gum, arabic gum, karaya, ghatti, tamarind gum, amyllose, high amyllose starch, hydroxypropylated high amyllose starch, dextrin, pectin, chitin, chitosan, levan, elsinan, collagen, gelatin, zein, gluten, soy protein isolate, whey protein isolate, casein, and mixtures thereof.

13. A beverage preparation capsule according to claim 1, wherein the area of said coating is from about 0.5 cm² to about 20 cm².

14. A beverage preparation capsule according to claim 1, wherein the weight of said coating is from about 1 mg to about 1 g, or the amount of said functional ingredients in said coating is from about 0.5 mg to about 500 mg.

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