

STABLE, SPRAY-DRIED PARTICLES AND PROCESS FOR OBTAINING SAME

TECHNICAL FIELD

The present disclosure relates to moisture and oxygen stable spray-dried particles including at least one volatile active component and methods of producing such particles. More particularly, the present disclosure relates to stable spray-dried particles including at least one volatile active component encapsulated in a matrix made from dextrin, potato maltodextrin and sugar.

BACKGROUND

Encapsulating volatile components in a solid encapsulating matrix is a well-known method. The advantages are numerous and include, for example, (i) the protection of the volatile component against undesired evaporation during storage, (ii) the protection of chemically sensitive components against chemical degradation, such as oxidation and hydrolysis, and (iii) the possibility to control the release of the encapsulated component.

Numerous methods can be used to produce solids comprising encapsulated volatile ingredients. However, the most common and economical way to encapsulate a volatile component involves the step of emulsifying the volatile component in an aqueous phase comprising encapsulating materials to form an oil-in-water emulsion and drying this emulsion by spray drying, spray granulation or spray coating to obtain a dry emulsion. The morphology of the dry product is that of a multitude of oil droplets in a glassy, polar, encapsulating matrix. The polar, encapsulating matrix is usually based on carbohydrate materials, such as modified starches, maltodextrins, mono-dissacharides and gums.

More and more consumers see these types of encapsulating matrices, especially modified starches, as something which is chemical or artificial and thus not desired. As a result, one such trend is the drive towards so-called “cleaner label” products. More specifically, the demand from customers and consumers is, in particular, directed to products that are free from or have a reduced percentage of artificial ingredients, which include modified starches and maltodextrins currently used as encapsulation ingredients.

There remains a need to provide spray dry carriers which can deliver superior authentic flavour to food or beverage products, and which can further benefit customers and consumers by achieving the foregoing whilst contributing to a cleaner label for the food or beverage product.

SUMMARY

In one illustrative embodiment, stable spray-dried particles include a water-soluble matrix including from about 5% to about 30% emulsifier; from about 20% to about 75% filler; and from about 20% to about 50% mono, di and trisaccharides, based on the total weight of the matrix; and at least one active component encapsulated in the matrix. The emulsifier is dextrin and the filler is potato maltodextrin.

In another illustrative embodiment, a process for preparing stable particles includes the steps of a) preparing a water-soluble matrix comprising from about 5% to about 30% dextrin; from about 20% to about 75% potato maltodextrin; and from about 20% to about 50% mono, di and trisaccharides, based on the total weight of the matrix; b) dissolving the matrix in water; c) adding an active component; d) mixing the matrix and active component to form an emulsion; and e) drying the emulsion.

These and other features, aspects and advantages of specific embodiments will become evident to those skilled in the art from a reading of the present disclosure.

DETAILED DESCRIPTION

The following text sets forth a broad description of numerous different embodiments of the present disclosure. The description is to be construed as exemplary only and does not describe every possible embodiment since describing every possible embodiment would be impractical, if not impossible. It will be understood that any feature, characteristic, component, composition, ingredient, product, step or methodology described herein can be deleted, combined with or substituted for, in whole or part, any other feature, characteristic, component, composition, ingredient, product, step or methodology described herein. Numerous alternative embodiments could be implemented, using either current technology or technology developed after the filing date of this patent, which would still fall within the scope of the claims. All publications and patents cited herein are incorporated herein by reference.

The present disclosure relates to spray-dried particles having a water-soluble matrix and a volatile active component encapsulated therein. The water-soluble matrix according to the present disclosure includes the combination of an emulsifier, a filler and mono, di and trisaccharides.

Water-soluble dried particles according to the present disclosure have an average size of from about 10 μm to about 200 μm ; in another embodiment from about 50 μm to about 100 μm . In one example, a particle may be unregularly shaped and the size of the particle is defined as the mean between the largest diameter of the particle and the smallest diameter of the particle. In

another example, a particle may be spherical and the size of the particle is defined as the diameter of the particle. The average size of a collection of particles may be obtained by different methods. For example, the particles may be observed under an optical microscope and the diameters of the particles, or of an arbitrary number of the particles, measured one by one and averaged to provide a number-averaged particle size. Alternatively, a cloud of particles may be measured by light scattering measurements using a Malvern 2000S instrument and the Mie scattering theory. The principle of the Mie theory and how light scattering can be used to measure capsule size can be found, for example H. C. van de Hulst, Light scattering by small particles, Dover, New York, 1981. The primary information provided by static light scattering is the angular dependence of the light scattering intensity, which in turn is linked to the size and shape of the particle in the cloud. However, in a standard operation method, the size of a sphere having a size equivalent to the size of the diffracting object, whatever the shape of this object, is calculated by the Malvern proprietary software provided with the apparatus. In case of polydisperse samples, the angular dependence of the overall scattering intensity contains information about the size distribution in the sample. The output is a histogram representing the total volume of capsules belonging to a given size class as a function of the capsule size, whereas an arbitrary number of 50 size classes can be chosen. Light scattering provides a volume-averaged particle size.

The term "emulsifier", as used herein, is intended to mean a surface-active agent that facilitates the mixing of two or more liquid substances that would separate into its component parts under normal conditions. In one embodiment, the emulsifier is dextrin. Dextrins are a group of low-molecular-weight carbohydrates produced by the hydrolysis of starch or glycogen. Dextrins used in the food industry are classified as white dextrins and are less viscous than the starch that they came from (potato, corn or rice, for instance). In one embodiment, the dextrin is derived from corn.

In accordance with one embodiment, dextrins useful in the present disclosure are capable of stabilizing an emulsion, i.e. capable of reducing the surface tension of water. For example, the surface tension of distilled water is 72.7 mN/m. Among the following, corn dextrin, modified starch, sugar and maltodextrin, corn dextrin is the most effective at reducing the surface tension of water—Corn Dextrin (1% solution) 37 mN/m; Modified Starch (1% solution) 45.2 mN/m; Sugar (5% solution) 72.5 mN/m; and 10 E Maltodextrin (5% solution) 66 mN/m.

The amount of dextrin present in the matrix can vary widely and may be based on the particular needs of the intended consumer, or the intended product form of the spray-dried particles. Also, the amount of dextrin present will depend on the percent flavour load, adjusted

as needed to form a good emulsion to produce good encapsulation. In certain exemplary embodiments, dextrin may be present in an amount of about 5% to about 30% by weight based on the total weight of the matrix. In another embodiment, dextrin may be present in an amount of about 7% to about 25% by weight based on the total weight of the matrix. In another embodiment, dextrin may be present in an amount of about 10% to about 20% by weight based on the total weight of the matrix. Dextrins are commercially available, for example, from Ingredion (Westchester, IL), under the trademark CAPSUL 2730.

Another component of the water-soluble matrix according to the present disclosure is a filler. In one embodiment, the filler is selected from potato maltodextrin. In certain exemplary embodiments, potato maltodextrin may be present in an amount of about 20% to about 75% by weight based on the total weight of the matrix. In another embodiment, potato maltodextrin may be present in an amount of about 40% to about 60% by weight based on the total weight of the matrix. Potato maltodextrins are commercially available for example, from AVEBE of Veedam, The Netherlands.

Another component of the water-soluble matrix according to the present disclosure are the mono, di and trisaccharides. In certain exemplary embodiments, mono, di and trisaccharides may be present in an amount of about 20% to about 50% by weight based on the total weight of the matrix. In another embodiment, mono, di and trisaccharides may be present in an amount of about 30% to about 40% by weight based on the total weight of the matrix. Illustrative examples of mono, di and trisaccharides are glucose, fructose, maltose, sucrose, raffinose and materials, having a high content of such sugars like fruit juice solids. In one embodiment, at least 50 wt. % of the mono, di and trisaccharide material is a disaccharide as a high amount of monosaccharide may result in a somewhat sticky product whereas a high amount of trisaccharide may lead to a product more prone to oxidation. In another embodiment according to the present disclosure the mono, di and trisaccharide material is sucrose.

In one embodiment, the water-soluble matrix includes at least one active component encapsulated therein. In one embodiment, the at least one active component is not restricted to a specific class of molecules. It may refer to a substance, a compound, and/or an ingredient, alone or a mixture thereof.

In one embodiment, the at least one active component is selected from volatile flavours and fragrances. The terms "flavour or fragrance" encompass flavour or fragrance ingredients or compositions of current use in the flavour and/or fragrance industry, of both natural and synthetic origin. It includes single compounds and mixtures. Specific examples of such flavour or fragrance ingredients may be found in the current literature, e.g. in Fenaroli's Handbook of

flavour ingredients, 1975, CRC Press; Synthetic Food adjuncts, 1947 by M. B. Jacobs, edited by Van Nostrand; or Perfume and Flavor Chemicals by S. Arctander, 1969, Montclair, N.J. (USA). The flavour or fragrance ingredients may be present in the form of a mixture with solvents, adjuvants, additives and/or other components, generally those of current use in the flavours and
5 fragrance industry.

In another embodiment, the at least one volatile active component may be selected from pharmaceuticals, vitamins, herbicides, fungicides, insecticides, detergents, cleaning agents and dyes.

10 Flavour and fragrance compositions may include a broad variety of mixtures of aromatic and fragrant ingredients, such as terpenes, terpene derivatives, esters, alcohols, ethers, ketones, lactones, aldehydes, anthranilates, nitriles, mercaptans, N- and S-heterocycles and the like.

Examples of suitable flavour ingredients include, but are not limited to, natural flavours, artificial flavours, spices, seasonings, synthetic flavour oils and flavoring aromatics and/or oils, oleoresins, essences, and distillates, and a combination comprising at least one of the foregoing.

15 Flavour oils include spearmint oil, cinnamon oil, oil of wintergreen (methyl salicylate), peppermint oil, Japanese mint oil, clove oil, bay oil, anise oil, eucalyptus oil, thyme oil, cedar leaf oil, oil of nutmeg, allspice, oil of sage, mace, oil of bitter almonds, and cassia oil; useful flavoring agents include artificial, natural and synthetic fruit flavours such as vanilla, and citrus oils including lemon, orange, lime, grapefruit, yuzu, sudachi, and fruit essences including apple,
20 pear, peach, grape, raspberry, blackberry, gooseberry, blueberry, strawberry, cherry, plum, prune, raisin, cola, guarana, neroli, pineapple, apricot, banana, melon, apricot, cherry, tropical fruit, mango, mangosteen, pomegranate, papaya, and so forth.

Additional exemplary flavours imparted by a flavour ingredient include a milk flavour, a butter flavour, a cheese flavour, a cream flavour, and a yogurt flavour, a vanilla flavour,
25 teaflavours, such as a green tea flavour, an oolong tea flavour, a cocoa flavour, a chocolate flavour, and a coffee flavour; mint flavours, such as a peppermint flavour, a spearmint flavour, and a Japanese mint flavour; spicy flavours, such as an asafetida flavour, an ajowan flavour, an anise flavour, an angelica flavour, a fennel flavour, an allspice flavour, a cinnamon flavour, a chamomile flavour, a mustard flavour, a cardamom flavour, a caraway flavour, a cumin flavour, a
30 clove flavour, a pepper flavour, a coriander flavour, a saffron flavour, a savory flavour, a Zanthoxyli Fructus flavour, a perilla flavour, a juniper berry flavour, a ginger flavour, a star anise flavour, a horseradish flavour, a thyme flavour, a tarragon flavour, a dill flavour, a capsicum flavour, a nutmeg flavour, a basil flavour, a parsley flavour, a marjoram flavour, a rosemary flavour, a bayleaf flavour, and a wasabi (Japanese horseradish) flavour; a nut flavour such as an

almond flavour, a hazelnut flavour, a macadamia nut flavour, a peanut flavour, a pecan flavour, a pistachio flavour, and a walnut flavour; floral flavours; and vegetable flavours, such as an onion flavour, a garlic flavour, a cabbage flavour, a carrot flavour, a celery flavour, mushroom flavour, and a tomato flavour.

5 According to some embodiments, flavour ingredients may also include aldehydes and esters such as cinnamyl acetate ((E)-3-phenylprop-2-en-1-yl acetate); cinnamaldehyde ((2E)-3-phenylprop-2-enal); citral diethylacetal ((E)-1,1-dimethoxy-3,7-dimethylocta-2,6-diene), dihydrocarvyl acetate (2-methyl-5-prop-1-en-2-ylcyclohexyl acetate), eugenyl formate ((2S)-1,3,3-trimethylbicyclo[2.2.1]heptan-2-yl acetate), p-methylanisol (1-methoxy-4-methylbenzene),
 10 and so forth can be used. Further examples of aldehyde flavourings include acetaldehyde (apple), benzaldehyde (cherry, almond), anisic aldehyde (4-methoxybenzaldehyde) (licorice, anise), cinnamic aldehyde ((2E)-3-phenylprop-2-enal) (cinnamon), citral (E)-3,7-dimethylocta-2,6-dienal, i.e., alpha-citral ((E)-3,7-dimethylocta-2,6-dienal (lemon, lime), neral, i.e., beta-citral ((E)-3,7-dimethylocta-2,6-dienal (lemon, lime), decanal (orange, lemon), ethyl vanillin
 15 (vanilla, cream), heliotrope, i.e., piperonal (benzo[d][1,3]dioxole-5-carbaldehyde) (vanilla, cream), vanillin (vanilla, cream), alpha-amyl cinnamaldehyde ((E or Z)-2-benzylideneheptanal) (spicy fruity flavours), butyraldehyde (butanal) (butter, cheese), valeraldehyde (pentanal) (butter, cheese), citronellal (3,7-dimethyloct-6-enal) (modifies, many types), decanal (citrus fruits), aldehyde C-8 (octanal) (citrus fruits), aldehyde C-9 (nonanal) (citrus fruits), aldehyde C-12
 20 (dodecanal) (citrus fruits), 2-ethyl butyraldehyde (2-ethylbutanal) (berry fruits), hexenal, i.e., trans-2 hexenal (berry fruits), tolyl aldehyde (4-methylbenzaldehyde) (cherry, almond), veratraldehyde (3,4-dimethoxybenzaldehyde) (vanilla), 2,6-dimethyl-5-heptenal, i.e., melonal (melon), 2,6-dimethyloctanal (green fruit), and 2-dodecenal (citrus, mandarin), and the like.

In another embodiment, flavour ingredients include natural compounds derived from
 25 Maillard reactions.

Examples of suitable fragrance ingredients include, but are not limited to hex-3-en-1-yl butyrate; 2-methyl-1-phenylpropan-2-yl acetate; 2-methyl-1-phenylpropan-2-yl butyrate; 4-(tert-butyl)cyclohexyl acetate; undecan-2-one; 2-benzylideneoctanal; 3,7-dimethylnona-1,6-dien-3-yl acetate; 3,7-dimethylocta-2,6-dien-1-yl acetate; 3,7-dimethylocta-2,6-dienal; non-6-enal; tridec-
 30 2-enenitrile; 1-((1,8a)-1,4,4,6-tetramethyl-2,3,3a,4,5,8-hexahydro-1-5,8a-methanoazulen-7-yl)ethanone; 1-(2,3,8,8-tetramethyl-1,2,3,4,5,6,7,8-octahydronaphthalen-2-yl)ethanone; 1-butoxy-1-oxopropan-2-yl butyrate; 2-methyl-1-phenylpropan-2-ol; allyl 2-(isopentyloxy)acetate; allyl 3-cyclohexylpropanoate; methyl non-2-ynoate; undec-9-enal; 1,3,4,5,6,7-hexahydro-
 .beta.,1,1,5,5-pentamethyl-2-2,4a-ethanonaphthalene-8-ethanol; 1-(1-ethoxyethoxy)hex-3-ene; 1-

(2,6,6-trimethylcyclohex-3-en-1-yl)but-2-en-1-one; 1-(2,6,6-trimethylcyclohexa-1,3-dien-1-yl)but-2-en-1-one; 1,1-diethoxy-3,7-dimethylocta-2,6-diene; 2-ethyl-4-(2,2,3-trimethylcyclopent-3-en-1-yl)but-2-en-1-ol; 3,7-dimethylnona-1,6-dien-3-ol; 3,7-dimethylocta-2,6-dien-1-yl isobutyrate; 3-methyl-2-(pent-2-en-1-yl)cyclopent-2-enone; 4-(2,5,6,6-tetramethylcyclohex-2-en-1-yl)but-3-en-2-one; 4-(2,6,6-trimethylcyclohex-1-en-1-yl)but-3-en-2-one; 4-(2,6,6-trimethylcyclohex-2-en-1-yl)but-3-en-2-one; 1,3,3-trimethylbicyclo[2.2.1]heptan-2-yl acetate; (2,4)-1,7,7-trimethylbicyclo[2.2.1]heptan-2-yl acetate; (ethoxymethoxy)cyclododecane; 1-(2,6,6-trimethylcyclohexa-1,3-dien-1-yl)but-2-en-1-one; 3,4,5,6,6-pentamethylhept-3-en-2-one; 3,7,11-trimethyldodeca-1,6,10-trien-3-yl acetate; 3,7-dimethylocta-2,6-dien-1-ol; 3,7-dimethylocta-2,6-dienal; 3-methyl-5-(2,2,3-trimethylcyclopent-3-en-1-yl)pent-4-en-2-ol; 3-methylcyclotetradec-5-enone; 4-((3a,7a)-hexahydro-1-4,7-methanoinden-5(6)-ylidene)butanal; 4-(2,6,6-trimethylcyclohex-2-en-1-yl)but-3-en-2-one; 4,11,11-trimethyl-8-methylenebicyclo[7.2.0]undec-4-ene; 4-methyldec-3-en-5-ol; 5-methylheptan-3-one oxime; methyl non-2-enoate; oxacyclohexadec-12-en-2-one; 1-((2-(tert-butyl)cyclohexyl)oxy)butan-2-ol; 1-(3,3-dimethylcyclohex-1-en-1-yl)pent-4-en-1-one; 1,2,4)-1,3,3-trimethylbicyclo[2.2.1]heptan-2-ol; 1,2,4)-2'-isopropyl-1,7,7-trimethylspiro[bicyclo[2.2.1]heptane-2,4'-[1,3]dioxane]; 1,2,5)-2-ethoxy-2,6,6-trimethyl-9-methylenebicyclo[3.3.1]nonane; 112) (4-(4-hydroxyphenyl)butan-2-one; 1-methyl-2-(5-methylhex-4-en-2-yl)cyclopropyl)-methanol; 1-methyl-4-(4-methylpent-3-en-1-yl)cyclohex-3-enecarbaldehyde; 1-methyl-4-propan-2-ylcyclohexa-1,4-diene; (1s,4s)-1,3,3-trimethyl-2-oxabicyclo[2.2.2]octane; 2-(4-methylcyclohex-3-en-1-yl)propan-2-yl acetate; 2-ethyl 3-isopropylbicyclo[2.2.1]hept-5-ene-2-carboxylate; 2,2-dimethoxyethyl)benzene; 2,6)-3,7-dimethylnona-2,6-dienenitrile; 2,6-dimethyloctan-2-ol; 2-isopropyl-5-methylcyclohexanol; 2-methyl-4-oxo-4-pyran-3-yl isobutyrate; 2-methyl-6-methyleneoct-7-en-2-yl acetate; 3-(4-isopropylphenyl)-2-methylpropanal; 3,5,5-trimethylhexyl acetate; 3,5-dimethylhex-3-en-2-yl)oxy)-2-methylpropyl cyclopropanecarboxylate; 3,7-dimethyloct-6-en-1-yl acetate; 3,7-dimethyloct-6-en-1-yl formate; 3,7-dimethyloct-6-en-1-yl propionate; 3,7-dimethyloct-6-enenitrile; 3,7-dimethylocta-1,6-dien-3-yl acetate; (3a,4,7,7a)-ethyl octahydro-1-4,7-methanoindene-3a-carboxylate; (3a,6,7a)-3a,4,5,6,7,7a-hexahydro-1-4,7-methanoinden-6-yl acetate; (3a,6,7a)-3a,4,5,6,7,7a-hexahydro-1-4,7-methanoinden-6-yl isobutyrate; (3a,6,7a)-3a,4,5,6,7,7a-hexahydro-1-4,7-methanoinden-6-yl propionate; (3-methyl-2-pentylcyclopent-2-enone; 4,7-dimethyloct-6-en-3-one; 4-methylene-2-phenyltetrahydro-2-pyran; 6,6-dimethoxy-2,5,5-trimethylhex-2-ene; allyl heptanoate; cyclohexyl 2-hydroxybenzoate; ethyl 2,6,6-trimethylcyclohexa-1,3-diene-1-carboxylate; ethyl heptanoate; ethyl hexanoate; hexyl isobutyrate; pentyl 2-hydroxybenzoate; propanedioic acid 1-(1-(3,3-dimethylcyclohexyl)ethyl) 3-

ethyl ester; 3-methyl-4-(2,6,6-trimethylcyclohex-2-en-1-yl)but-3-en-2-one; 1-(3,3-dimethylcyclohexyl)ethyl formate; 1-(3,5,5,6,8,8-hexamethyl-5,6,7,8-tetrahydronaphthalen-2-yl)ethanone; 1-(spiro[4.5]dec-6-en-7-yl)pent-4-en-1-one; 1,1,2,3,3-pentamethyl-2,3,6,7-tetrahydro-1-inden-4(5)-one; decanal; 2-methyldecanal; undec-10-enal; undecanal; 2-methylundecanal; 1-methyl-4-(prop-1-en-2-yl)cyclohex-1-ene; 1-methyl-4-(prop-1-en-2-yl)cyclohex-1-ene; 1-methyl-4-(propan-2-ylidene)cyclohex-1-ene; 2- (isopropyl 2-methyl butanoate; 2-(1-(3,3-dimethylcyclohexyl)ethoxy)-2-methylpropyl cyclopropanecarboxylate; 2-(2-(4-methylcyclohex-3-en-1-yl)propyl)cyclopentanone; 2-(2,4-dimethylcyclohexyl)pyridine; 2-(sec-butyl)cyclohexanone; 2-(tert-butyl)cyclohexyl acetate; 2,2,2-trichloro-1-phenylethyl acetate; 2,2,5-trimethyl-5-pentylcyclopentanone; 2,2-dimethyl-2-phenylethyl propanoate; 2,4,6-trimethyl-4-phenyl-1,3-dioxane; 2,4,6-trimethylcyclohex-3-enecarbaldehyde; 2,6,10-trimethylundec-9-enal; 2,6-dimethylhept-5-enal; 2,6-dimethylheptan-2-ol; 2-cyclohexylidene-2-(o-tolyl)acetonitrile; 2-cyclohexylidene-2-phenylacetonitrile; 2-ethyl--methyl--(m-tolyl)butanamide; 2-isopropyl-5-methylcyclohexanone; 2-methyl-4-methylene-6-phenyltetrahydro-2-pyran; 2-methyldecanenitrile; 2-pentylcyclopentanone; 3-(3-isopropylphenyl)butanal; 3-(4-(tert-butyl)phenyl)-2-methylpropanal; 3-(4-ethylphenyl)-2,2-dimethylpropanal; 3-(4-isobutyl-2-methylphenyl)propanal; 3-(4-isobutylphenyl)-2-methylpropanal; 3,7-dimethyloct-6-en-1-ol; 3,7-dimethyloct-6-enal; 3,7-dimethylocta-1,6-dien-3-ol; 3,7-dimethyloctan-3-ol; 4-(4-methylpent-3-en-1-yl)cyclohex-3-enecarbaldehyde; 4-(tert-pentyl)cyclohexanone; 4,4a,5,9b-tetrahydroindeno[1,2-d][1,3]dioxine; 4-cyclohexyl-2-methylbutan-2-ol; 5-(sec-butyl)-2-(2,4-dimethylcyclohex-3-en-1-yl)-5-methyl-1,3-dioxane; 5-tert-butyl-2-methyl-5-propyl-2-furan; 6-(sec-butyl)quinoline; 6,8-dimethylnonan-2-ol; 6-ethyl-3-methyloct-6-en-1-ol; 8-(sec-butyl)-5,6,7,8-tetrahydroquinoline; 8,8-dimethyl-1,2,3,4,5,6,7,8-octahydronaphthalene-2-carbaldehyde; allyl 2-(cyclohexyloxy)acetate; dec-4-enal; dec-9-en-1-ol; dodec-2-enal; dodecanal; dodecanenitrile; ethyl 2-ethyl-6,6-dimethylcyclohex-2-enecarboxylate; ethyl 2-methylpentanoate; ethyl octanoate; hex-3-en-1-yl methyl carbonate; hexyl 2-hydroxybenzoate; methyl 3-oxo-2-pentylcyclopentaneacetate; oxacyclohexadecan-2-one; and the like.

In one embodiment, a major application of the present disclosure is related to the field of flavours. In this respect it is noted that the final spray-dried product may be capable of protecting and retaining about 5 to about 40 wt. % and in another embodiment about 20 to about 30 wt. % flavour active component, depending on the type of active component and based on the total weight of the flavour. Examples of flavour active components, in particular aromatic or volatile flavour active components, to be encapsulated in the matrix according to the present

disclosure are for instance essential oils, like citrus oil and other volatile flavour active components, like bakery and savoury flavour active components.

The spray-dried particles may include from about 0.5% to about 50%, in another embodiment from about 1% to about 30%, in yet another embodiment about 25%, or any individual number within the range, by weight of the particle of at least one active component. In one embodiment, the level of free active component, (i.e. surface oil level) is lower than about 1.5%, in another embodiment lower than about 1%, in another embodiment lower than about 0.3% and in yet another embodiment lower than about 0.15% by weight of the spray-dried particles. Surface oil level should be minimized. The amount of surface oil that can be tolerated without negative impact on processing and/or encapsulation performance will depend on the composition of the flavour which will determine its volatility and oxidation stability. Lower oil loading and increasing the emulsifier level will help to reduce surface oil. For higher oil loadings the addition of plasticizer such as fruit or vegetable concentrates containing natural sugars and food acids will help reduce surface oil.

The spray-dried particles according to the present disclosure may be used in a wide variety of consumables or applications and is not restricted to any particular physical mode or product form. According to the present disclosure, the term “consumable” refers to products for consumption by a subject, typically via the oral cavity (although consumption may occur via non-oral means such as inhalation), for at least one of the purposes of enjoyment, nourishment, or health and wellness benefits. Consumables may be present in any form including, but not limited to, liquids, solids, semi-solids, tablets, capsules, lozenges, strips, powders, gels, gums, pastes, slurries, solutions, suspensions, syrups, aerosols and sprays. The term also refers to, for example, dietary and nutritional supplements. Consumables include compositions that are placed within the oral cavity for a period of time before being discarded but not swallowed. It may be placed in the mouth before being consumed, or it may be held in the mouth for a period of time before being discarded.

Broadly, consumables include, but are not limited to, comestibles of all kinds, confectionery products, baked products, sweet products, savoury products, fermented products, dairy products, beverages, oral care products, nutraceuticals and pharmaceuticals.

Exemplary comestibles include, but are not limited to, chilled snacks, sweet and savoury snacks, fruit snacks, chips/crisps, extruded snacks, tortilla/corn chips, popcorn, pretzels, nuts, other sweet and savoury snacks, snack bars, granola bars, breakfast bars, energy bars, fruit bars, other snack bars, meal replacement products, slimming products, convalescence drinks, ready meals, canned ready meals, frozen ready meals, dried ready meals, chilled ready meals, dinner

mixes, meat analogues, frozen pizza, chilled pizza, soup, canned soup, dehydrated soup, instant soup, chilled soup, UHT soup, frozen soup, pasta, canned pasta, dried pasta, chilled/fresh pasta, noodles, plain noodles, instant noodles, cups/bowl instant noodles, pouch instant noodles, chilled noodles, snack noodles, dried food, dessert mixes, sauces, dressings and condiments, herbs and spices, spreads, jams and preserves, honey, chocolate spreads, nut-based spreads, and yeast-based spreads.

Exemplary confectionery products include, but are not limited to, chewing gum (which includes sugarized gum, sugar-free gum, functional gum and bubble gum), centerfill confections, chocolate and other chocolate confectionery, medicated confectionery, lozenges, tablets, pastilles, mints, standard mints, power mints, chewy candies, hard candies, boiled candies, breath and other oral care films or strips, candy canes, lollipops, gummies, jellies, fudge, caramel, hard and soft panned goods, toffee, taffy, liquorice, gelatin candies, gum drops, jelly beans, nougats, fondants, combinations of one or more of the above, and edible flavour compositions incorporating one or more of the above.

Exemplary baked products include, but are not limited to, alfajores, bread, packaged/industrial bread, unpackaged/artisanal bread, pastries, cakes, packaged/industrial cakes, unpackaged/artisanal cakes, cookies, chocolate coated biscuits, sandwich biscuits, filled biscuits, savoury biscuits and crackers, and bread substitutes.

Exemplary sweet products include, but are not limited to, breakfast cereals, ready-to-eat (“rte”) cereals, family breakfast cereals, flakes, muesli, other ready to eat cereals, children's breakfast cereals, and hot cereals.

Exemplary savoury products include, but are not limited to, salty snacks (potato chips, crisps, nuts, tortilla-tostada, pretzels, cheese snacks, corn snacks, potato-snacks, ready-to-eat popcorn, microwaveable popcorn, pork rinds, nuts, crackers, cracker snacks, breakfast cereals, meats, aspic, cured meats (ham, bacon), luncheon/breakfast meats (hotdogs, cold cuts, sausage), tomato products, margarine, peanut butter, soup (clear, canned, cream, instant, ultrahigh temperature “UHT”), canned vegetables, and pasta sauces.

Exemplary dairy products include, but are not limited to, cheese, cheese sauces, cheese-based products, ice cream, impulse ice cream, single portion dairy ice cream, single portion water ice cream, multi-pack dairy ice cream, multi-pack water ice cream, take-home ice cream, take-home dairy ice cream, ice cream desserts, bulk ice cream, take-home water ice cream, frozen yoghurt, artisanal ice cream, milk, fresh/pasteurized milk, full fat fresh/pasteurized milk, semi skimmed fresh/pasteurized milk, long-life/uht milk, full fat long life/uht milk, semi skimmed long life/uht milk, fat-free long life/uht milk, goat milk, condensed/evaporated milk, plain

condensed/evaporated milk, flavoured, functional and other condensed milk, flavoured milk drinks, dairy only flavoured milk drinks, flavoured milk drinks with fruit juice, soy milk, sour milk drinks, fermented dairy drinks, coffee whiteners, powder milk, flavoured powder milk drinks, cream, yoghurt, plain/natural yoghurt, flavoured yoghurt, fruited yoghurt, probiotic
5 yoghurt, drinking yoghurt, regular drinking yoghurt, probiotic drinking yoghurt, chilled and shelf-stable desserts, dairy-based desserts, and soy-based desserts.

Exemplary beverages include, but are not limited to, flavoured water, soft drinks, fruit drinks, coffee-based drinks, tea-based drinks, juice-based drinks (includes fruit and vegetable), milk-based drinks, gel drinks, carbonated or non-carbonated drinks, powdered drinks, alcoholic
10 or non-alcoholic drinks, and ready to drink liquid formulations of these beverages.

Exemplary fermented foods include, but are not limited to, cheese and cheese products, meat and meat products, soy and soy products, fish and fish products, grain and grain products, fruit and fruit products.

The spray-dried particles according to the present disclosure may be used in a wide
15 variety of applications besides the food-related consumables mentioned hereinabove. In one embodiment, the spray-dried particles may be used in fragrance applications and especially in applications wherein a burst-like fragrance release is desired. There are numerous examples of situations, where such triggered release is desired by consumers. For example, the spray-dried particles may be admixed with a powder detergent, and the fragrance released when this mixture
20 is added to water. Alternatively, the spray-dried particles may be used everywhere wherein moisture is involved, such as deodorant products, toilet blocs, dish wash tablets, pet litters, diapers, sanitary napkins, feminine hygiene products, mouth hygiene products such as denture cleaning tablets and toothpastes and the like.

The particles according to the present disclosure may be produced using standard spray
25 drying equipment and typical conditions known to the art. In another embodiment, particles according to the present disclosure may be produced using multistage dryer (MSD) equipment and typical conditions known in the art. Conditions may naturally vary depending on the nature of the equipment and the material being sprayed, but the person skilled in the art can readily determine the appropriate conditions in every case with only routine experimentation. Typical
30 examples of conditions that produce dry powder with a moisture content of less than 5% and water activity in the desirable range of from 0.05 to 0.30 at 25°C. Water activity (A_w) is the partial vapor pressure of water in a substance divided by the standard state partial vapor pressure of water. It is a measurement of the relative humidity of the sample in a closed chamber - basically A_w is the equilibrium humidity emitted by the sample material.

Typical parameters for use on a conventional tower spray dryer are:

Inlet temperature - 100-250°C

Outlet temperature - 60-120°C

The finished material size should be about greater than or equal to about 40 µm mean diameter by volume distribution, as measured by laser diffraction particle size instrument. Other non-limiting examples of suitable drying techniques include fluid bed drying, freeze drying, filtermat and drum drying.

The disclosure is further described with reference to the following non-limiting examples.

EXAMPLES

The following examples are given solely for the purpose of illustration and are not to be construed as limitations of the present invention, as many variations of the invention are possible without departing from the spirit and scope of the present disclosure.

Emulsion Utilizing Flavour Oil (Limonene)

The first emulsion includes a commercially available matrix including modified starch and a maltodextrin (Example A—control) used to encapsulate a limonene flavour. The second emulsion include the same limonene flavour encapsulated in a matrix according to the present disclosure (Example B).

Emulsions were prepared from the ingredients listed below:

Table 1
(Example A)

Ingredients (kg)	15% load	20% load	25% load
Limonene	4.5	6	7.5
Modified Starch	5.1	4.8	4.5
Maltodextrin	10.2	9.6	9
Sugar	10.2	9.6	9
Distilled Water	20	20	20

Table 2

(Example B)

Ingredients (kg)	15% load	20% load	25% load
Limonene	4.5	6	7.5
Corn Dextrin	5.1	4.8	4.5
Potato Maltodextrin	10.2	9.6	9
Sugar	10.2	9.6	9
Distilled Water	20	20	20

5 Emulsions according to the present disclosure were prepared as follows: Corn dextrin and filler (potato maltodextrin) were dissolved in water. The volatile active component was added to the water phase containing the dissolved emulsifier and filler under high shear mixing, for example, IKA mixer to create an emulsion. High shear mixing means mixing at a speed and time sufficient to produce an emulsion (1 micron or less as determined by light scattering particle size analysis) from the mixture of matrix ingredients and active component(s). By way of illustration, but not in limitation, the matrix ingredients and active component(s) may be mixed at a speed of at least 8000 RPM for at least 5 minutes. Further non-limiting embodiments of high shear mixing includes mixing the matrix ingredients and active component(s) at a speed of about 5,000 RPM to about 12,000 RPM for about 10 minutes to about 2 minutes, respectively.

15 The compositions of the samples are reported on Tables 1 and 2. The emulsions are then spray-dried using an Anhydro PSD55 spray drying unit equipped with a rotary atomizer and a peristaltic delivery pump. Inlet and outlet temperatures were respectively 170°C ($\pm$ 5°C) and 95°C ($\pm$ 3°C). The powder was recovered by means of a cyclone separator.

20 Stability Results

The compositions from Tables 1 and 2 were tested for oxidative stability by determining the proportion of D-limonene remaining after various periods of storage. The samples were stored at 40°C and 30% relative humidity in LDPE bags of a type that did not provide a barrier to moisture absorption. Samples were analyzed by GC and MS.

The results are shown in Tables 3, 4 and 5. Tables 3 and 4 show the proportion of D-limonene remaining and Table 5 shows the proportion of oxidation by-products present.

Table 3

5

Stability Study Results—Limonene Levels

Example	Initial	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks	24 weeks
A, 15%	15.81	15.65	15.17	15.11	15.08	14.95	14.88
A, 20%	20.46	19.77	19.66	19.55	19.70	19.40	19.32
A, 25%	25.97	25.58	25.94	25.04	25.08	24.91	24.67
B, 15%	15.09	14.46	14.45	14.47	14.49	14.48	14.36
B, 20%	19.88	19.06	19.07	18.97	19.14	19.02	19.02
B, 25%	24.89	24.13	23.57	23.51	23.57	23.48	23.25

Table 4

Stability Study Results—Limonene Retention Results

Example	Initial	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks	24 weeks
A, 15%	100	99.0	96.0	95.6	95.4	94.6	94.1
A, 20%	100	96.6	96.1	95.6	96.3	94.8	94.4
A, 25%	100	98.5	99.9	96.4	96.6	95.9	95.0
B, 15%	100	95.8	95.8	95.9	96.0	96.0	95.2
B, 20%	100	95.9	95.9	95.4	96.3	95.7	95.7
B, 25%	100	96.9	94.7	94.5	94.7	94.3	93.4

10

Table 5

Stability –Oxidation By-Products Level

Example	Initial	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks	24 weeks
A, 15%	0.66	1.13	1.15	1.41	1.34	1.84	2.10
A, 20%	0.47	0.75	1.11	1.29	1.46	1.78	2.00
A, 25%	0.34	0.53	0.85	1.01	1.32	1.47	1.73
B, 15%	0.41	0.82	1.27	1.55	1.43	1.66	1.94
B, 20%	0.35	0.73	0.91	1.11	1.12	1.34	1.47

B, 25%	0.33	0.55	0.89	1.13	1.25	1.39	1.72
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From Tables 3, 4 and 5 above, it can be seen that the composition of Example B is comparable with the compositions of Example A (control) for stability and retention. Importantly, these results were obtained using no modified starches, maltodextrins or GMO encapsulation ingredients.

The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as “40 mm” is intended to mean “about 40 mm”.

While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

What is claimed is:

1. Stable spray-dried particles comprising:
a water-soluble matrix including from 5% to 30% emulsifier; from 20% to 75% filler; and
5 from 20% to 50% mono, di and trisaccharides, based on the total weight of the matrix;
and
at least one active component encapsulated in the matrix;
wherein the emulsifier is dextrin and the filler is potato maltodextrin.
- 10 2. The stable spray-dried particles according to claim 1, wherein the dextrin is derived from corn.
3. The stable spray-dried particles according to claim 1, wherein the emulsifier is present in an amount of from 10% to 20%, based on the total weight of the matrix.
- 15 4. The stable spray-dried particles according to claim 1, wherein the at least one active component is selected from the group consisting of flavour and fragrance ingredients.
5. The stable spray-dried particles according to claim 4, wherein the at least one active
20 component is present in an amount of from 1% to 30%, based on the total weight of the matrix.
6. The stable spray-dried particles according to claim 1, wherein at least 50% of the mono, di and trisaccharide material is disaccharide.
- 25 7. The stable spray-dried particles according to claim 1, wherein 100% of the mono, di and trisaccharide material is sucrose.
8. The stable spray-dried particles according to claim 4, wherein the at least one active component is a citrus oil.
- 30 9. A delivery system comprising the stable spray-dried particles according to claim 1.
10. A consumable comprising the stable spray-dried particles according to claim 1.

11. The stable spray-dried particles according to claim 1, wherein the particles have an average particle size of from 50 μm to 100 μm .