SUMMARY OF THE INVENTION

[004] In one embodiment, the disclosure provides a dry stabilizing composition for a bioactive material, including a carbohydrate component including between about 10% and 80% oligosaccharide, between about 5% and 30% disaccharide and between about 1% and 10%) polysaccharide; and a protein component including between about 0.5% and 40% hydrolyzed animal or plant proteins; based on the total weight of the composition. The composition may be combined with a bioactive material.

[005] In another embodiment, the disclosure provides a method of producing the above composition combined with the bioactive material, including: (a) combining the bioactive material with at least the carbohydrate component and the protein component in an aqueous solvent to form a viscous slurry; (b) snap-freezing the slurry in liquid nitrogen to form solid frozen particles, beads, droplets or strings; (c) primary drying by water removal under vacuum of the product of step (b) while maintaining it at a temperature above its freezing temperature; and (d) secondary drying of the product of step (c) at maximum vacuum and a temperature of 20°C or higher for a time sufficient to reduce the water activity to below 0.3 Aw.

[006] In another embodiment, the disclosure provides a tablet, pill or pellet made by compaction of a sensitive bioactive material embedded in a dry glassy and amorphous composition including one or more sugars and one or more hydrolyzed proteins, wherein the sugars include between about 10% and 60% and the hydrolyzed proteins include between about 1% and 40% based on the total dry weight of the composition.

[007] In yet another embodiment, the disclosure provides a method for producing the above-mentioned tablet, pill or pellet, including compacting the sensitive bioactive material embedded in the dry glassy and amorphous composition, wherein the dry glassy and amorphous composition is made by a process including: (a) combining a bioactive material with at least the one or more sugars and the one or more hydrolyzed proteins in an aqueous solvent to form a viscous slurry; (b) snap-freezing the slurry in liquid nitrogen to form solid frozen particles, beads, droplets or strings; (c) primary drying by water removal under vacuum of the product of step (b) while maintaining it at a temperature above its freezing temperature; and (d) secondary drying of the product of step (c) at maximum vacuum and temperature of 20°C or higher for a time sufficient to reduce the water activity to below 0.3 Aw.

[007a] In one ~~aspect of the invention~~embodiment, there is provided a dry stabilizing composition for a bioactive material, comprising a carbohydrate component comprising one or more oligosaccharides, one or more disaccharides and one or more polysaccharides; and a protein

component comprising one or more hydrolyzed animal or plant proteins. The composition may be combined with the bioactive material.

One aspect relates to a dry stabilizing composition in an amorphous glassy state, comprising a bioactive material, one or more disaccharides at 10-50%, one or more oligosaccharides at 10-80%, one or more polysaccharides at 0.1-10%, one or more hydrolyzed proteins at 0.5-40%, and one or more carboxylic acid salts, each percentage based on the total weight of the composition.

Another aspect relates to a dry stabilizing composition in an amorphous glassy state, comprising a bioactive material, one or more disaccharides at 10-50%, one or more oligosaccharides at 10-80%, one or more polysaccharides at 0.1-10%, one or more hydrolyzed proteins at 0.5-40%, and one or more carboxylic acid salts, each percentage based on the total weight of the composition, and wherein the composition is prepared by a method comprising:

(a) combining the bioactive material with the one or more disaccharides, the one or more oligosaccharides, the one or more polysaccharides, the one or more hydrolyzed proteins, and the one or more carboxylic acid salts in an aqueous solvent to form a viscous slurry;

(b) snap-freezing the slurry in liquid nitrogen to form solid frozen particles in the form of beads, droplets or strings;

(c) primary drying the frozen particles by evaporation under vacuum at a temperature above the freezing temperature of the particles to form a primarily dried formulation; and

(d) secondary drying the primarily dried formulation at maximum vacuum and a temperature of 20 °C or higher for a time sufficient to reduce the water activity of the primarily dried formulation to below 0.3 Aw, whereby the composition is prepared.

[007b] In yet another ~~aspect~~embodiment, there is provided a method for producing the composition disclosed above, the method comprising: (a) combining the bioactive material with at least the carbohydrate component and the protein component in an aqueous solvent to form a viscous slurry; (b) snap-freezing the slurry in liquid nitrogen to form solid frozen particles, beads, droplets or strings; (c) primary drying by water removal under vacuum of the product of step (b) while maintaining it at a temperature above its freezing temperature; and (d) secondary drying of the product of step (c) at maximum vacuum and a temperature of 20°C or higher for a time sufficient to reduce the water activity to below 0.3 Aw.

[007c] Another aspect provides a reconstituted liquid, a ground powder, a tablet, a pellet, a capsule, a food or feed or coated seed product comprising the composition disclosed above.

[007d] Still another aspect provides a nutraceutical, pharmaceutical agricultural or vaccine product comprising the composition disclosed above.

[007e] Another aspect provides a food, food additive, animal feed, animal feed additive, nutraceutical, pharmaceutical, agricultural or vaccine product in the form of a bar, liquid formula, colloidal suspension, powder, tablet, capsule and coated seed, comprising the composition disclosed above.

[007f] Yet another ~~aspect~~ embodiment provides a tablet, pill or pellet made by compaction of a sensitive bioactive material embedded in a dry glassy and amorphous composition comprising one or more sugars and one or more hydrolyzed proteins, wherein the sugars comprise between about 10% and 60% and the hydrolyzed proteins comprise between about 1 % and 40% based on the total dry weight of the composition.

[007g] Another ~~aspect~~ embodiment provides a method for producing the tablet, pill or pellet disclosed herein, comprising compacting the sensitive bioactive material embedded in the dry glassy and amorphous composition, wherein the dry glassy and amorphous composition is made by a process comprising: (a) combining a bioactive material with at least the one or more sugars and the one or more hydrolyzed proteins in an aqueous solvent to form a viscous slurry; (b) snap-freezing the slurry in liquid nitrogen to form solid frozen particles, beads, droplets or strings; (c) primary drying by water removal under vacuum of the product of step (b) while maintaining it at a temperature above its freezing temperature; and (d) secondary drying of the product of step (c) at maximum vacuum and temperature of 20°C or higher for a time sufficient to reduce the water activity to below 0.3 Aw.

[007h] Another ~~aspect~~ embodiment provides a beverage, food, animal feed, nutraceutical, pharmaceutical, agricultural or vaccine product comprising the tablet, pill or pellet disclosed herein.

CLAIMS

What is claimed:

1. A dry stabilizing composition for a bioactive material, comprising a carbohydrate component comprising one or more oligosaccharides, one or more disaccharides and one or more polysaccharides; and a protein component comprising one or more hydrolyzed animal or plant proteins.

2. The composition of claim 1, wherein the hydrolyzed protein component comprises hydrolyzed casein, hydrolyzed whey protein, hydrolyzed pea protein, hydrolyzed soy protein or a mixture thereof.

3. The composition of claim 2, wherein the hydrolyzed casein, hydrolyzed whey protein, hydrolyzed pea protein and hydrolyzed soy protein are extensively hydrolyzed proteins.

4. The composition of any preceding claim, wherein the polysaccharide comprises cellulose acetate phthalate (CAP), carboxy-methyl-cellulose, pectin, sodium alginate, salts of alginic acid, hydroxyl propyl methyl cellulose (HPMC), methyl cellulose, carrageenan, gellan gum, guar gum, gum acacia, xanthan gum, locust bean gum, chitosan and chitosan derivatives, collagen, polyglycolic acid, starches, modified starches or a mixture thereof.

5. The composition of any preceding claim, wherein the oligosaccharide comprises cyclodextrins, inulin, maltodextrins, dextrans, fructo-oligosaccharides (FOS), galacto-oligosaccharides (GOS), mannan-oligosaccharides (MOS) or a mixture thereof.

6. The composition of any preceding claim, wherein the disaccharide comprises trehalose, sucrose, lactose, or a mixture thereof.

7. The composition of any preceding claim, further comprising a carboxylic acid component comprising between about 0.5% and 10% carboxylic acid, based on the total weight of the composition.

8. The composition of claim 7, wherein the carboxylic acid component comprises lactic acid, ascorbic acid, maleic acid, oxalic acid, malonic acid, malic acid, succinic acid, citric acid, gluconic acid, glutamic acid, their salts or mixtures of these.

9. The composition of any preceding claim, wherein the composition is combined with the bioactive material.

10. The composition of claim 9, wherein the bioactive material comprises a live, dead or attenuated cell, microbe, virus, bacteria, probiotic bacteria, plant bacteria, soil bacteria, fungi, yeast, cell culture, protein, recombinant protein, enzyme, peptide, hormone, vaccine, antibiotic, drug or a mixture thereof.

11. The composition of any preceding claim, wherein the composition is dried in an amorphous glassy state.

12. The composition of claim 11, wherein the composition is dried by one or more processes selected from the group consisting of air drying, vacuum-drying, fluid bed drying and spray-drying.

13. A method for producing the composition of claim 9, comprising: (a) combining the bioactive material with at least the carbohydrate component and the protein component in an aqueous solvent to form a viscous slurry; (b) snap-freezing the slurry in liquid nitrogen to form solid frozen particles, beads, droplets or strings; (c) primary drying by water removal under vacuum of the product of step (b) while maintaining it at a temperature above its freezing temperature; and (d) secondary drying of the product of step (c) at maximum vacuum and a temperature of 20°C or higher for a time sufficient to reduce the water activity to below 0.3 Aw.

14. The method of claim 13, wherein the slurry is solidified to a firm hydrogel by pH or temperature change or by cross linking of polymer chains with metal ions before snap freezing.

15. The method of claim 14 wherein the slurry is molded to a desired shape.

16. The method of claim 13 wherein the primary water removal step is carried out under vacuum pressure higher than >2000 mTORR.

17. The method of claim 13, wherein the dried material is cut, crushed, milled or respectively pulverized into a free flowing powder.

18. A composition made by the method of claim 17, wherein the particle size is less than about 1000 μm.

19. A reconstituted liquid, a ground powder, a tablet, a pellet, a capsule, a food or feed or coated seed product comprising the composition of claim 9.

20. A nutraceutical, pharmaceutical agricultural or vaccine product comprising the composition of claim 9.

21. A food, food additive, animal feed, animal feed additive, nutraceutical, pharmaceutical, agricultural or vaccine product in the form of a bar, liquid formula, colloidal suspension, powder, tablet, capsule and coated seed, comprising the composition of claim 9.

22. A composition made by the method of claim 13.

23. A tablet, pill or pellet made by compaction of a sensitive bioactive material embedded in a dry glassy and amorphous composition comprising one or more sugars and one or more hydrolyzed proteins, wherein the sugars comprise between about 10% and 60% and the hydrolyzed proteins comprise between about 1 % and 40% based on the total dry weight of the composition.

24. The tablet, pill or pellet of claim 23, wherein the bioactive material comprises a live, dead or attenuated cell, microbe, virus, bacteria, probiotic bacteria, plant and soil bacteria fungi or a yeast, a cell culture a protein, a recombinant protein, an enzyme, a peptide, a hormone, a vaccine, an antibiotic, a drug, or a mixture thereof.

25. The tablet, pill or pellet of claim 23 or 24, wherein the hydrolyzed proteins comprise extensively hydrolyzed casein, whey protein, pea protein, soy protein or a mixture thereof.

26. The tablet, pill or pellet of any one of claims 23-25, wherein the sugars are disaccharides selected from the group consisting of trehalose, sucrose, lactose, and mixtures thereof.

27. The tablet, pill or pellet of any one of claims 23-26, wherein a glass enhancing compound is included in the composition, wherein the glass enhancing compound comprises between about 1% and 20% based on the total dry weight of the composition.

28. The tablet, pill or pellet of claim 27, wherein the glass enhancing compound comprises ions of formic acid, oxalic acid, ascorbic acid, phosphoric acid or a combination thereof.

29. The tablet, pill or pellet of any one of claims 23-28, wherein the composition further comprises a polysaccharide or an oligosaccharide or a mixture thereof.

30. The tablet, pill or pellet of claim 29, wherein the composition comprises a polysaccharide selected from the group consisting of cellulose acetate phthalate (CAP), carboxy-methyl-cellulose, pectin, sodium alginate, salts of alginic acid, hydroxyl propyl methyl cellulose (HPMC), methyl cellulose, carrageenan, gellan gum, guar gum, gum acacia, xanthan gum, locust bean gum, chitosan and chitosan derivatives, collagen, polyglycolic acid, starches, modified starches and mixtures thereof, and wherein the polysaccharide comprises between about 0.1 and 10% of the total dry weight of the composition.

31. The tablet, pill or pellet of claim 29 or 30, wherein the composition comprises an oligosaccharide selected from the group consisting of cyclodextrins, inulin, maltodextrins, dextrans, fructo-oligosaccharides (FOS), galacto-oligosaccharides (GOS), mannan-oligosaccharides (MOS) and mixtures thereof, and wherein the oligosaccharide comprises between about 0.5 and 20% of the total dry weight of the composition.

32. The tablet, pill or pellet of any one of claims 23-31, wherein the composition is dried in an amorphous glassy state.

33. The tablet, pill or pellet of claim 32 wherein the composition is dried by a method comprising one or more processes selected from the group consisting of air drying, vacuum-drying, fluid bed drying and spray-drying.

34. A method for producing the tablet, pill or pellet of any one of claims 23-33, comprising compacting the sensitive bioactive material embedded in the dry glassy and amorphous composition, wherein the dry glassy and amorphous composition is made by a process comprising: (a) combining a bioactive material with at least the one or more sugars and the one or more hydrolyzed proteins in an aqueous solvent to form a viscous slurry; (b) snap-freezing the slurry in liquid nitrogen to form solid frozen particles, beads, droplets or strings; (c) primary drying by water removal under vacuum of the product of step (b) while maintaining it at a temperature above its freezing temperature; and (d) secondary drying of the product of step (c) at maximum vacuum and temperature of 20°C or higher for a time sufficient to reduce the water activity to below 0.3 Aw.

35. The method of claim 34, wherein the slurry is solidified to a firm hydrogel by pH or temperature change or by cross linking of polymer chains with metal ions before snap freezing.

36. The method of claim 34 wherein the primary water removal step is carried out under vacuum of 2000 mTORR or more.

37. The method of claim 34, wherein the dried material is cut, crushed, milled or respectively pulverized into a free flowing powder.

38. The method of claim 37, wherein the particle size of the powder is less than about 1000 μm.

39. The tablet, pill or pellet of any one of claims 23-33, wherein the bioactive material is stable in compaction or compression in tablet press equipment.

40. A beverage, food, animal feed, nutraceutical, pharmaceutical, agricultural or vaccine product comprising the tablet, pill or pellet of any one of claims 23-33.

41. A tablet, pill or pellet made by the method of claim 34.

42. The dry stabilizing composition of claim 1, wherein the one or more disaccharides are present at 10-90%, the one or more oligosaccharides are present at 1-10%, and the one or more polysaccharides are present at 0.1-10%, based on the total weight of the composition.

43. The dry stabilizing composition of claim 1, wherein the one or more disaccharides are present at 10-50%, the one or more oligosaccharides are present at 10-80%, and the one or more polysaccharides are present at 0.1-10%, based on the total weight of the composition.

44. The dry stabilizing composition of claim 1, wherein the hydrolyzed animal or plant proteins are present at 0.5- 40%, based on the total weight of the composition.

CLAIMS

1. A dry stabilizing composition in an amorphous glassy state, comprising a bioactive material, one or more disaccharides at 10-50%, one or more oligosaccharides at 10-80%, one or more polysaccharides at 0.1-10%, one or more hydrolyzed proteins at 0.5-40%, and one or more carboxylic acid salts, each percentage based on the total weight of the composition.

2. The composition of claim 1, wherein the one or more oligosaccharides consist of cyclodextrin.

3. The composition of claim 1, wherein the one or more hydrolyzed proteins are selected from the group consisting of hydrolyzed casein, hydrolyzed whey protein, hydrolyzed pea protein, hydrolyzed soy protein, and a mixture thereof.

4. The composition of claim 1, wherein the one or more polysaccharides are selected from the group consisting of cellulose acetate phthalate (CAP), carboxy-methyl-cellulose, pectin, salts of alginic acid, hydroxyl propyl methyl cellulose (HPMC), methyl cellulose, carrageenan, gellan gum, guar gum, gum acacia, xanthan gum, locust bean gum, chitosan and chitosan derivatives, collagen, polyglycolic acid, starches, modified starches, and a mixture thereof.

5. The composition of claim 1, wherein the one or more disaccharides are selected from the group consisting of trehalose, sucrose, lactose, and a mixture thereof.

6. The composition of claim 1, wherein the carboxylic acid is selected from the group consisting of lactic acid, ascorbic acid, maleic acid, oxalic acid, malonic acid, malic acid, succinic acid, citric acid, gluconic acid, and glutamic acid.

7. The composition of claim 1, wherein the bioactive material comprises a live, dead or attenuated cell, a microbe, a virus, a bacterium, a probiotic bacterium, a plant bacterium, a soil bacterium, a fungus, a yeast, a cell culture, a protein, a recombinant protein, an enzyme, a peptide, a hormone, a vaccine, an antibiotic, a drug, or a mixture thereof.

8. The composition of claim1, wherein the composition is dried by one or more processes selected from the group consisting of air drying, vacuum-drying, fluid bed drying and spray-drying.

9. A reconstituted liquid, a ground powder, a tablet, a pellet, a capsule, a food, a feed, or a coated seed product prepared with the composition of claim 1.

10. A nutraceutical, pharmaceutical agricultural or vaccine product comprising the composition of claim 1.

11. A food, food additive, animal feed, animal feed additive, nutraceutical, pharmaceutical, agricultural or vaccine product in the form of a bar, liquid formula, colloidal suspension, powder, tablet, capsule, or coated seed, prepared with the composition of claim 1.

12. A dry stabilizing composition in an amorphous glassy state, comprising a bioactive material, one or more disaccharides at 10-50%, one or more oligosaccharides at 10-80%, one or more polysaccharides at 0.1-10%, one or more hydrolyzed proteins at 0.5-40%, and one or more carboxylic acid salts, each percentage based on the total weight of the composition, and wherein the composition is prepared by a method comprising:

(a) combining the bioactive material with the one or more disaccharides, the one or more oligosaccharides, the one or more polysaccharides, the one or more hydrolyzed proteins, and the one or more carboxylic acid salts in an aqueous solvent to form a viscous slurry;

(b) snap-freezing the slurry in liquid nitrogen to form solid frozen particles in the form of beads, droplets or strings;

(c) primary drying the frozen particles by evaporation under vacuum at a temperature above the freezing temperature of the particles to form a primarily dried formulation; and

(d) secondary drying the primarily dried formulation at maximum vacuum and a temperature of 20 °C or higher for a time sufficient to reduce the water activity of the primarily dried formulation to below 0.3 Aw, whereby the composition is prepared.

13. The composition of claim 12, wherein the bioactive material comprises a live, dead or attenuated cell, a microbe, a virus, a bacterium, a probiotic bacterium, a plant bacterium, a soil bacterium, a fungus, a yeast, a cell culture, a protein, a recombinant protein, an enzyme, a peptide, a hormone, a vaccine, an antibiotic, a drug, or a mixture thereof.

14. The composition of claim 12, wherein the one or more disaccharides are selected from the group consisting of trehalose, sucrose, lactose, and a mixture thereof.

15. The composition of claim 12, wherein the one or more oligosaccharides are selected from the group consisting of cyclodextrins, inulin, maltodextrins, dextrans, fructo-oligosaccharides (FOS), galacto-oligosaccharides (GOS), mannan-oligosaccharides (MOS), and a mixture thereof.

16. The composition of claim 12, wherein the one or more oligosaccharides consist of cyclodextrin.

17. The composition of claim 12, wherein the one or more polysaccharides are selected from the group consisting of cellulose acetate phthalate (CAP), carboxy-methyl-cellulose, pectin, sodium alginate, salts of alginic acid, hydroxyl propyl methyl cellulose (HPMC), methyl cellulose, carrageenan, gellan gum, guar gum, gum acacia, xanthan gum, locust bean gum, chitosan and chitosan derivatives, collagen, polyglycolic acid, starches, modified starches, and a mixture thereof.

18. The composition of claim 12, wherein the one or more hydrolyzed proteins are selected from the group consisting of hydrolyzed casein, hydrolyzed whey protein, hydrolyzed pea protein, hydrolyzed soy protein, and a mixture thereof.

19. The composition of claim 12, wherein the carboxylic acid is selected from the group consisting of lactic acid, ascorbic acid, maleic acid, oxalic acid, malonic acid, malic acid, succinic acid, citric acid, gluconic acid, and glutamic acid.