CLAIMS

1. A method of preparing a beverage component, comprising:

contacting a substrate carrier material, having an endogenous Maillard-reactive nitrogen constituent and/or an endogenous Maillard-reactive carbohydrate constituent, with an exogenous Maillard reagent comprising an exogenous Maillard-reactive nitrogen constituent and/or an exogenous Maillard-reactive carbohydrate constituent to provide a conditioned substrate carrier material; and

adjusting the water activity (a_w) of the conditioned substrate carrier material to a value less than that of the conditioning reaction, and reacting, during the adjusting and/or at the adjusted a_w value, the exogenous Maillard reagent with the endogenous Maillard-reactive nitrogen constituent and/or with the endogenous Maillard-reactive carbohydrate constituent to provide a low water activity (low a_w) cross-Maillardized substrate carrier material having cross-Maillard reaction products (LWACMP) formed by the reaction between the exogenous Maillard reagent, and the endogenous Maillard-reactive constituent(s).

2. The method of claim 1, wherein the conditioned substrate carrier material, prior to adjusting the a_w, comprises a cross-Maillardized substrate carrier material having cross-Maillard reaction products (HWACMP).

3. The method of claim 1 or 2, wherein the endogenous Maillard-reactive nitrogen constituent comprises one or more of amino acids, oligopeptides, polypeptides, and/or proteins, and/or wherein the endogenous Maillard-reactive carbohydrate constituent comprises one or more of mono-, di-, oligosaccharide, and/or polysaccharides.

4. The method of any one of claims 1-3, wherein the exogenous Maillard-reactive nitrogen constituent comprises one or more of amino acids, oligopeptides, polypeptides, and/or proteins, and/or wherein the exogenous Maillard-reactive carbohydrate constituent comprises one or more of mono-, di-, oligosaccharide, and/or polysaccharides.

5. The method of any one of claims 1-4, wherein the exogenous Maillard-reactive nitrogen constituent comprises one or more amino acids, and/or wherein the exogenous Maillard-reactive carbohydrate constituent comprises one or more mono- or disaccharides.

6. The method of any one of claims 1-5, wherein the substrate carrier material comprises a natural and/or a processed or restructured plant material having the endogenous Maillard-reactive nitrogen constituent and/or the endogenous Maillard-reactive carbohydrate constituent.

7. The method of claim 6, wherein the plant material comprises one or more selected from the group consisting of date seeds, chicory root, Yerba mate stems and/or leaves, dandelion, seeds from the mustard family (*Brassicaceae*), watermelon seeds, pumpkin seeds, Jerusalem artichokes, sesame seeds, apricot seeds, cereal and non-cereal grains, ~~and/or~~ coffee, and combinations thereof.

8. The method of any one of claims 1-7, wherein contacting the substrate carrier material with the exogenous Maillard reagents comprises contacting with an aqueous solution of the exogenous Maillard reagents.

9. The method of any one of claims 1-8, wherein contacting the substrate carrier material with the exogenous Maillard reagent comprises contacting at least the surface of the substrate carrier material with the exogenous Maillard reagent, and promoting adsorption, absorption, or covalently or physical adherence ~~(e.g., covalently or physically)~~ of the exogenous Maillard reagent, and/or of reaction products thereof, to at least the surface of the conditioned carrier material.

10. The method of any one of claims 1-9, wherein contacting the substrate carrier material with the exogenous Maillard reagent comprises contacting at one or more conditioning temperature(s), under conditions and for a time period sufficient to provide for infusion of the exogenous Maillard reagent into at least the surface of the substrate carrier material, and/or solubilization and/or permeabilization, and/or depolymerization of the endogenous Maillard-reactive nitrogen constituent and/or the endogenous Maillard-reactive carbohydrate constituent thereof.

11. The method of any one of claims 1-10, wherein the LWACMP comprises cross-Maillardized reaction products on at least the surface thereof.

12. The method of any one of claims 1-11, wherein adjusting the a_w comprises adjusting to a value less than or equal to a value selected from the group consisting of 0.95, 0.90, 0.85. 0.80, 0.75, 0.70, 0.65, 0.6, 0.55, 0.5, 0.45, 0.4, 0.35, 0.3, 0.25, 0.2, 0.15 and 0.1, or

less than or equal to a value in a range of 0.10 to 0.95, ~~including adjusting to a value less than or equal to any value~~ or in any subranges therein ~~(e.g., 0.20 to 0.85, 0.25 to 0.80, 0.25 to 0.75, 0.25 to 0.70, 0.25 to 0.65, 0.25 to 0.60, 0.25 to 0.55), preferably to a value in a range of 0.25 to 0.70~~.

13. The method of any one of claims 1-12, wherein adjusting the a_w comprises drying the conditioned substrate carrier material at one or more drying temperatures.

14. The method of any one of claims 1-13, further comprising restructuring one or more of the substrate carrier material, the conditioned substrate carrier material, and/or the LWACMP.

15. The method of any one of claims 1-14, wherein the restructuring comprises one or more of fragmenting, grinding, milling, micronizing, depolymerizing, solubilizing, permeabilizing, compacting and/or compressing the respective substrate carrier material.

16. The method of any one of claims 1-15, further comprising heating the LWACMP under conditions sufficient to promote further Maillardization thereof, to provide an elevated temperature, cross-Maillardized substrate carrier material having cross-Maillard reaction products (ET-LWACMP).

17. The method of claim 16, wherein the adjusting the water activity (a_w) of the conditioned substrate carrier material to provide the LWACMP, and the heating of the LWACMP to provide the ET-LWACMP are stages of one or more continuous or ramped heating process(es).

18. The method of claim 16 or 17, wherein the further Maillardization comprises further cross-Maillardization relative to the LWACMP.

19. The method of any one of claims 16-18, wherein the heating is at one or more temperatures greater than the temperature used for adjusting the water activity (a_w) of the conditioned substrate carrier material~~, or than the drying temperature~~.

20. The method of any one of claims 16-19, wherein the heating comprises one or more of roasting, toasting, baking, grilling, and/or otherwise thermally treating at elevated temperatures.

21. The method of any one of claims 16-20, further comprising grinding, or otherwise fragmenting, grinding, milling, micronizing, depolymerizing, solubilizing, permeabilizing, compacting, compressing and/or otherwise restructuring the ET-LWACMP.

22. The method of any one of claims 1-21, wherein the level of at least one compound present in the conditioned substrate carrier material, the LWACMP, the ET-LWACMP, or in extracts thereof is differentially modulated relative to that of the substrate carrier material or that of the exogenous reagent(s) independently subjected to the method, taken alone or in sum.

23. The method of claim 22, wherein the at least one compound ~~comprises~~ is selected from the group consisting of 2,5-dimethylpyrazine, 2,3-butanedione, 1,3-bis[(5S)-5-amino-5-carboxypentyl]-4-methyl-1H-imidazol-3-ium, ~~and/or of~~ γ-butyrolactone, and combinations thereof.

24. The method of any one of claims 1-23, further comprising extracting the conditioned substrate carrier material, the LWACMP or the ET-LWACMP to provide an extract, and an extracted retentate substrate carrier material.

25. The method of claim 24, wherein the extracting comprises suffusing or steeping in a suitable solvent ~~(e.g., water, ethanol, glycol, supercritical CO_2, etc.)~~ at a suitable temperature, wherein the extract comprises an infusion, and wherein the extracted retentate substrate carrier material comprises extracted retentate restructured substrate and/or grounds.

26. The method of claim 24 or 25, further comprising addition of one or more additional ingredients to the extract to provide a blended formula.

27. The method of claim 26, wherein the one or more additional ingredients comprises one or more of dry ingredients, liquid ingredients, oil, and/or gum ingredients.

28. The method of any one of claims 24-27, comprising concentrating the extract or the blended formula, to provide a concentrated extract or concentrated blended formula.

29. The method of any one of claims 24-28, further comprising subjecting the extract or the blended formula, or the concentrates thereof, to one or more of a sterilization process ~~(e.g. UHT, retort, microwave, ohmic)~~, a pasteurization process ~~(e.g. HTST)~~, a

homogenization process, or non-thermal antimicrobial treatments ~~(e.g. HPP, irradiation) etc.~~, optionally followed by packaging or aseptic packaging.

30. The method of any one of claims 24 - 29, further comprising drying of the extracted retentate substrate carrier material to provide a dried, extracted retentate substrate carrier material.

31. The method of claim 30, further comprising addition of one or more additional ingredients to the dried, extracted retentate substrate carrier material to provide a formulated retentate substrate carrier material.

32. The method of claim 31, wherein the addition of the one or more additional ingredients, comprises coating or infusing the dried, extracted retentate substrate carrier material.

33. The method of claim 31 or 32, wherein the one or more additional ingredients comprises one or more of dry ingredients, liquid ingredients, oil, gum ingredients, and/or an extract or lyophilized or dried extract of the LWACMP or of the ET-LWACMP.

34. The method of any one of claims 24-29, further comprising instantizing the extract, the blended formula, or the concentrates thereof, to provide an instantized beverage component, optionally followed by aseptic packaging.

35. The method of any one of claims 1-34, wherein the substrate carrier material comprises or is coffee or spent coffee grounds.

36. A beverage component, comprising a component prepared ~~by~~ according to the method of any one of claims 1-35.

37. The beverage component of claim 36, wherein the beverage component comprises one or more beverage components selected from the group consisting of:

a conditioned substrate carrier material having cross-Maillard reaction products (HWACMP);

a low a_w cross-Maillardized substrate carrier material (LWACMP) having cross-Maillard reaction products;

an elevated temperature, cross-Maillardized substrate carrier material (ET-LWACMP) having cross-Maillard reaction products formed by heating the LWACMP under conditions sufficient to promote further Maillardization thereof;

an extract of the HWACMP, the LWACMP, or the ET-LWACMP, or concentrates, blends or formulations thereof;

an extracted retentate substrate carrier material having cross-Maillard reaction products; and

a concentrated and/or instantized beverage component; and wherein any of these components are optionally packaged in single-use or multi-use pods, capsule, ~~etc~~or the like.

38. A cross-Maillardized substrate carrier material, or an extract thereof, comprising:

a low water activity (low a_w) cross-Maillard reaction product (LWACMP) formed, at an a_w value less than or equal to 0.95, between an endogenous Maillard-reactive nitrogen constituent and an exogenous Maillard-reactive carbohydrate constituent, and/or between an exogenous Maillard-reactive nitrogen constituent and an endogenous Maillard-reactive carbohydrate constituent; and/or

an elevated temperature, low water activity cross-Maillard product (ET-LWACMP).

39. The cross-Maillardized substrate carrier material, or the extract thereof, of claim 38, comprising the LWACMP and the ET-LWACMP.

40. The cross-Maillardized substrate carrier material, or the extract thereof, of claim 38 or 39, wherein the endogenous Maillard-reactive nitrogen constituent comprises one or more of amino acids, oligopeptides, polypeptides, and/or proteins, and/or wherein the endogenous Maillard-reactive carbohydrate constituent comprises one or more of mono-, di-, oligosaccharide, and/or polysaccharides.

41. The cross-Maillardized substrate carrier material, or the extract thereof, of any one of claims 38-40, wherein the exogenous Maillard-reactive nitrogen constituent comprises one or more of amino acids, oligopeptides, polypeptides, and/or proteins, and/or wherein the exogenous Maillard-reactive carbohydrate constituent comprises one or more of mono-, di-, oligosaccharide, and/or polysaccharides.

42. The cross-Maillardized substrate carrier material, or the extract thereof, of any one of claims 38-41, wherein the exogenous Maillard-reactive nitrogen constituent comprises

one or more amino acids, and/or wherein the exogenous Maillard-reactive carbohydrate constituent comprises one or more mono- or disaccharides.

43. The cross-Maillardized substrate carrier material, or the extract thereof, of any one of claims 38-42, wherein the substrate carrier material comprises a natural and/or a processed or restructured plant material.

44. The cross-Maillardized substrate carrier material, or the extract thereof, of claim 43 wherein the plant material comprises one or more selected from the group consisting of date seeds, chicory root, Yerba mate stems and/or leaves, dandelion, seeds from the mustard family (*Brassicaceae*), watermelon seeds, pumpkin seeds, Jerusalem artichokes, sesame seeds, apricot seeds, cereal and non-cereal grains, ~~and/or~~ coffee, and combinations thereof.

45. The cross-Maillardized substrate carrier material, or the extract thereof, of claim 44 wherein the plant material comprises or is coffee or spent coffee grounds.

46. The cross-Maillardized substrate carrier material, or the extract thereof, of any one of claims 38-45, wherein the cross-Maillardized substrate carrier material comprises one or more of:

a kernel or restructured form of the cross-Maillardized substrate carrier material having LWACMP, of the cross-Maillardized substrate carrier material having ET-LWACMP, or of the cross-Maillardized substrate carrier material having LWACMP and ET-LWACMP;

an extract (e.g., aqueous) of the kernel or fragmented form of the cross-Maillardized substrate carrier material having LWACMP, of the cross-Maillardized substrate carrier material having ET-LWACMP, or of the cross-Maillardized substrate carrier material having LWACMP and ET-LWACMP;

a concentrated and/or instantized extract of the kernel or fragmented form of the cross-Maillardized substrate carrier material having LWACMP, of the cross-Maillardized substrate carrier material having ET-LWACMP, or of the cross-Maillardized substrate carrier material having LWACMP and ET-LWACMP; and

an extracted retentate cross-Maillardized substrate carrier material having LWACMP, having ET-LWACMP, or having LWACMP and ET-LWACMP; and wherein any of these components are optionally packaged in single-use or multi-use pods, capsule, etc.

47. The cross-Maillardized substrate carrier material, or the extract thereof, of any one of claims 38-46, in the form of a beverage or beverage component.

48. The cross-Maillardized substrate carrier material, or the extract thereof, of any one of claims 38-47, wherein the level of at least one compound present in the LWACMP, and/or in the ET-LWACMP, or in extracts thereof is differentially modulated relative to that of a corresponding non-cross-Maillardized substrate carrier material.

49. The cross-Maillardized substrate carrier material, or the extract thereof, of claim, 48 wherein the at least one compound is selected from the group consisting of~~comprises~~ 2,5-dimethylpyrazine, 2,3-butanedione, 1,3-bis[(5S)-5-amino-5-carboxypentyl]-4-methyl-1H-imidazol-3-ium, ~~and/or of~~ γ-butyrolactone, and combinations thereof.

50. A cross-Maillard-primed substrate carrier material, comprising a non-liquid combination of: a substrate carrier material having an endogenous Maillard-reactive nitrogen constituent and/or an endogenous Maillard-reactive carbohydrate constituent; and an exogenous Maillard reagent having an exogenous Maillard-reactive nitrogen constituent and/or an exogenous Maillard-reactive carbohydrate constituent, wherein the non-liquid combination is formulated and/or conditioned~~primed (sufficient or capable)~~ to produce a cross-Maillardized substrate carrier material upon adjustment of water activity (a_w), and/or heating, and/or drying thereof~~; optionally packaged in single-use or multi-use pods, capsule, etc~~.

51. The cross-Maillard-primed substrate carrier material of claim 50, wherein:

the endogenous Maillard-reactive nitrogen constituent comprises one or more of amino acids, oligopeptides, polypeptides, and/or proteins; and/or wherein

the endogenous Maillard-reactive carbohydrate constituent comprises one or more of mono-, di-, oligosaccharide, and/or polysaccharides; and/or wherein

the exogenous Maillard-reactive nitrogen constituent comprises one or more of amino acids, oligopeptides, polypeptides, and/or proteins; and/or wherein

the exogenous Maillard-reactive carbohydrate constituent comprises one or more of mono-, di-, oligosaccharide, and/or polysaccharides.

52. The cross-Maillard-primed substrate carrier material of claim 50 or 51, wherein

adjusting the a_w comprises adjusting to a value greater than 0.95, or to a value less than or equal to a value selected from the group consisting of 0.95, 0.90, 0.85. 0.80, 0.75, 0.70, 0.65, 0.6, 0.55, 0.5, 0.45, 0.4, 0.35, 0.3, 0.25, 0.2, 0.15 and 0.10, or less than or equal to a value in a range of 0.10 to 0.95, ~~including adjusting to a value less than or equal to any value~~ or in any

subranges therein ~~(e.g., 0.20 to 0.85, 0.25 to 0.80, 0.25 to 0.75, 0.25 to 0.70, 0.25 to 0.65, 0.25 to 0.60, 0.25 to 0.55), preferably to a value in a range of 0.25 to 0.70~~; wherein

drying comprises adjusting the a_w to a value less than or equal to a value selected from the group consisting of 0.95, 0.90, 0.85. 0.80, 0.75, 0.70, 0.65, 0.6, 0.55, 0.5, 0.45, 0.4, 0.35, 0.3, 0.25, 0.2, 0.15 and 0.10, or less than or equal to a value in a range of 0.10 to 0.95, ~~including adjusting to a value less than or equal to any value~~ or in any subranges therein ~~(e.g., 0.20 to 0.85, 0.25 to 0.80, 0.25 to 0.75, 0.25 to 0.70, 0.25 to 0.65, 0.25 to 0.60, 0.25 to 0.55), preferably to a value in a range of 0.25 to 0.70~~; and wherein

heating comprises heating at, or to, a temperature above ambient temperature.

53. The cross-Maillard-primed substrate carrier material of any one of claims 50-52, wherein the non-liquid combination comprises a powder or particle form of either the substrate carrier material, the exogenous Maillard reagent, or both.

54. The cross-Maillard-primed substrate carrier material of any one of claims 50-53, wherein the substrate carrier material and/or the exogenous Maillard reagent are in the form of a bound or unbound aggregate, a direct compression, a dry granulation, wet granulation, or extrusion ~~and in each case may optionally comprise one or more further excipients (e.g., binder, distintegrant, lubricant, etc.)~~.

55. The cross-Maillard-primed substrate carrier material of any one of claims 50-54, wherein the substrate carrier material and the exogenous Maillard reagent are in the form of a compressed or compacted, bound or unbound, kernel, bean, pellet or other form.

56. The cross-Maillard-primed substrate carrier material of any one of claims 50-55, wherein the substrate carrier material comprises a natural and/or a processed or restructured plant material.

57. The cross-Maillard-primed substrate carrier material of claim 56, wherein the plant material comprises one or more selected from the group consisting of date seeds, chicory root, Yerba mate stems and/or leaves, dandelion, seeds from the mustard family (*Brassicaceae*), watermelon seeds, pumpkin seeds, Jerusalem artichokes, sesame seeds, apricot seeds, cereal and non-cereal grains, ~~and/or~~ coffee, and combinations thereof.

58. The cross-Maillard-primed substrate carrier material of claim 57, wherein the plant material comprises or is coffee or spent coffee grounds.

59. A method of making a cross-Maillard-primed substrate carrier material, comprising combining:

a substrate carrier material having an endogenous Maillard-reactive nitrogen constituent and/or an endogenous Maillard-reactive carbohydrate constituent; and

an exogenous Maillard reagent having an exogenous Maillard-reactive nitrogen constituent and/or and exogenous Maillard-reactive carbohydrate constituent, to provide a non-liquid combination, wherein the non-liquid combination is formulated and/or conditioned~~primed (sufficient or capable)~~ to produce a cross-Maillardized substrate carrier material upon adjustment of water activity (a_w), and/or heating, and/or drying thereof.

60. The method of claim 59, wherein:

the endogenous Maillard-reactive nitrogen constituent comprises one or more of amino acids, oligopeptides, polypeptides, and/or proteins; and/or wherein

the endogenous Maillard-reactive carbohydrate constituent comprises one or more of mono-, di-, oligosaccharide, and/or polysaccharides; and/or wherein

the exogenous Maillard-reactive nitrogen constituent comprises one or more of amino acids, oligopeptides, polypeptides, and/or proteins; and/or wherein

the exogenous Maillard-reactive carbohydrate constituent comprises one or more of mono-, di-, oligosaccharide, and/or polysaccharides.

61. The method of claim 59 or 60, wherein:

adjusting the a_w comprises adjusting to a value greater than 0.95, or to a value less than or equal to a value selected from the group consisting of 0.95, 0.90, 0.85. 0.80, 0.75, 0.70, 0.65, 0.6, 0.55, 0.5, 0.45, 0.4, 0.35, 0.3, 0.25, 0.2, 0.15 and 0.10, or less than or equal to a value in a range of 0.10 to 0.95, ~~including adjusting to a value less than or equal to any value~~ or in any subranges therein ~~(e.g., 0.20 to 0.85, 0.25 to 0.80, 0.25 to 0.75, 0.25 to 0.70, 0.25 to 0.65, 0.25 to 0.60, 0.25 to 0.55), preferably to a value in a range of 0.25 to 0.70~~; wherein

drying comprises adjusting the a_w to a value less than or equal to a value selected from the group consisting of 0.95, 0.90, 0.85. 0.80, 0.75, 0.70, 0.65, 0.6, 0.55, 0.5, 0.45, 0.4, 0.35, 0.3, 0.25, 0.2, 0.15 and 0.10, or less than or equal to a value in a range of 0.10 to 0.95, ~~including adjusting to a value less than or equal to any value~~ or in any subranges therein ~~(e.g., 0.20 to 0.85, 0.25 to 0.80, 0.25 to 0.75, 0.25 to 0.70, 0.25 to 0.65, 0.25 to 0.60, 0.25 to 0.55), preferably to a value in a range of 0.25 to 0.70~~; and wherein

heating comprises heating at, or to, a temperature above ambient temperature.

62. The method of any one of claims 59-61 wherein the non-liquid combination comprises a powder or particle form of either the substrate carrier material, the exogenous Maillard reagent, or both.

63. The method of any one of claims 59-62, wherein the substrate carrier material and/or the exogenous Maillard reagent are in the form of a bound or unbound aggregate, a direct compression, a dry granulation, wet granulation, or extrusion~~, and in each case may optionally comprise one or more further excipients (e.g., binder, disintegrant, lubricant, etc.)~~.

64. The method of any one of claims 59-63, wherein the substrate carrier material and the exogenous Maillard reagent are in the form of a compressed or compacted, bound or unbound, kernel, bean, pellet or other form.

65. The method of any one of claims 59-64, wherein the substrate carrier material comprises or is a natural and/or a processed or restructured plant material.

66. The method of any one of claims 59-65, wherein the plant material comprises or is one or more selected from the group consisting of date seeds, chicory root, Yerba mate stems and/or leaves, dandelion, seeds from the *Brassicaceae* family, watermelon seeds, pumpkin seeds, Jerusalem artichokes, sesame seeds, apricot seeds, cereal and non-cereal grains, ~~and/or~~ coffee, and combinations thereof.

67. The method of claim 66, wherein t the plant material comprises or is coffee or spent coffee grounds.

68. A cross-Maillard-primed substrate carrier material, prepared according to the method of any one of claims 59-67.

69. A method for imparting flavor and/or aroma to a cross-Maillardized or non-cross-Maillardized carrier material comprising: obtaining a substrate carrier material; and applying thereto a beverage component according to claim 36 or 37, and/or applying thereto a cross-Maillardized substrate carrier material, or an extract thereof, according to any one of claims 38-49.

70. The method of claim 69, wherein the carrier material comprises or is a natural and/or a processed or restructured plant material.

71. The method of claim 70, wherein the plant material comprises one or more materials selected from the group consisting of date seeds, chicory root, Yerba mate stems and/or leaves, dandelion, seeds from the *Brassicaceae* family, watermelon seeds, pumpkin seeds, Jerusalem artichokes, sesame seeds, apricot seeds, cereal and non-cereal grains, ~~and/or~~ coffee, and combinations thereof.

72. The method of claim 71, wherein the plant material comprises or is coffee or spent coffee grounds.

73. A flavor and/or aroma enhanced carrier material prepared according to~~by~~ the method of any one of claims 69-72.