

CLAIMS

1. A powder composition comprising a probiotic entrapped or encapsulated in a matrix comprising protein and carbohydrate from a non-fermented biomass from a single species of organism.
2. The composition of claim 1, wherein the entrapped or encapsulated probiotic has higher viability compared to the untrapped or unencapsulated probiotic.
3. The composition of claim 1 or claim 2, wherein the entrapped or encapsulated probiotic has higher viability compared to the untrapped or unencapsulated probiotic after treatment with/in one or more or all of the following conditions:
 - i) a temperature of about 4°C to about 40°C;
 - ii) a pH of about 1 to about 7;
 - iii) a pH of about 1 to about 5;
 - iv) simulated gastric fluid;
 - v) gastric fluid;
 - vi) digestive enzymes;
 - vii) simulated intestinal fluid;
 - viii) intestinal fluid;
 - ix) transit through the upper gastrointestinal tract;
 - x) the lower gastrointestinal tract;
 - xi) freeze drying; and
 - xii) sterilization.
4. The composition of any one of claims 1 to 3, wherein the composition is synbiotic.
5. The composition of any one of claims 1 to 4, wherein the probiotic is one or more of the following:
 - i) a beneficial bacteria;
 - ii) a lactic acid bacteria;
 - iii) a bacteria that produces one or more short chain fatty acid/s (SCFA) when in the gastrointestinal tract;
 - iv) a bacteria that assists with the production of one or more short chain fatty acid/s (SCFA) in the gastrointestinal tract;

- v) isolated from a *Brassicaceae*;
vi) isolated from broccoli;
vii) isolated from *Daucus carota*; and
5 viii) an autochthonous bacteria from the biomass.
6. The composition of claim 5, wherein the lactic acid bacteria is selected from one or more of the genera selected from: *Lactobacillus*, *Leuconostoc*, *Pediococcus*, *Lactococcus*, *Streptococcus*, *Aerococcus*, *Carnobacterium*, *Enterococcus*, *Oenococcus*,
10 *Sporolactobacillus*, *Tetragenococcus*, *Vagococcus* and *Weissella*.
7. The composition of claim 5 or claim 6, wherein the lactic acid bacteria is selected from one or more of: *Leuconostoc mesenteroides*, *Lactobacillus plantarum*, *Lactobacillus pentosus*, *Lactobacillus brevis*, *Lactococcus lactis*, *Pediococcus*
15 *pentosaceus*, *Lactobacillus rhamnosus*, *Pediococcus acidilacti*, BF1 deposited under V17/021729 on 25 September 2017 at the National Measurement Institute 1/153 Bertie Street, Port Melbourne, Victoria, Australia 3207, BF2 deposited under V17/021730 on 25 September 2017 at the National Measurement Institute 1/153 Bertie Street, Port Melbourne, Victoria, Australia 3207, B1 deposited under V17/021731 on 25 September
20 2017 at the National Measurement Institute 1/153 Bertie Street, Port Melbourne, Victoria, Australia 3207, B2 deposited under V17/021732 on 25 September 2017 at the National Measurement Institute 1/153 Bertie Street, Port Melbourne, Victoria, Australia 3207, B3 deposited under V17/021733 on 25 September 2017 at the National Measurement Institute 1/153 Bertie Street, Port Melbourne, Victoria, Australia 3207, B4
25 deposited under V17/021734 on 25 September 2017 at the National Measurement Institute 1/153 Bertie Street, Port Melbourne, Victoria, Australia 3207, and B5 deposited under V17/021735 on 25 September 2017 at the National Measurement Institute 1/153 Bertie Street, Port Melbourne, Victoria, Australia 3207.
- 30 8. The composition of claim 5, wherein the bacteria that produces one or more SCFA is selected from one or more of: *Faecalibacterium prausnitzii*, *Roseburia intestinalis*, *Roseburia faecis*, *Roseburia inulinivorans*, *Eubacterium rectale*, *Eubacterium halii*, *Anaerostipes hadrus*, *Anaerostipes caccae*, *Butyrivibrio crossotus*, *Clostridium cluster XIVa*, *Bifidobacterium spp.*, *Bacteroidetes* and *Negativicutes* classes of *Firmicutes*.

11. The composition of any one of claims 1 to 10, wherein the oil is entrapped or encapsulated in the matrix, and wherein the entrapped or encapsulated oil is resistant to degradation compared to the unentrapped or unencapsulated oil.
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12. The composition of claim 10 or claim 11, wherein the oil is resistant to degradation by one or more of: oxygen, temperature, pH, moisture, light, and pro-oxidants.
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13. The composition of any one of claims 10 to 12, wherein the oil is resistant to degradation at one or more of the following conditions:
- i) for at least one week when stored at about 40°C;
 - ii) for at least two weeks when stored at about 40°C;
 - iii) for at least 5 months when stored at about 24°C; and
 - 15 iv) for at least 12 months when stored at about 24°C.
14. The composition of any one of claims 10 to 13, wherein the oil comprises one or more fatty acid/s.
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15. The composition of any one of claims 10 to 14, wherein the fatty acid is selected from one or more of: omega-3, omega-6 or an omega-9 fatty acid.
16. The composition of claim 15, wherein the omega-3 fatty acid is one or more of α -linolenic acid (ALA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA) and
- 25 docosahexaenoic acid (DHA).
17. The composition of any one of claims 10 to 16, wherein the oil is selected from one or more of: fish oil, krill oil, algal oil, marine oil, fungal oil, nut or seed oil, canola oil, sunflower oil, avocado oil, soya oil, borage oil, evening primrose oil, safflower oil,
- 30 flaxseed oil, olive oil, pumpkinseed oil, hemp seed oil, wheat germ oil, palm oil, palm olein, palm kernel oil, coconut oil, medium chain triglycerides and grapeseed oil.
18. The composition of claim 17, wherein the fish oil or marine oil is selected from one or more of: tuna oil, herring oil, mackerel oil, sardine oil, cod liver oil, menhaden
- 35 oil, shark oil, algal oil, squid oil, and squid liver oil.

19. The composition of any one of claims 1 to 18, wherein the composition comprises a further non-fermented biomass comprising protein and carbohydrate from at least one further single species of organism.
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20. The composition of any one of claims 1 to 19, wherein one or more components of the biomass or further biomass is a prebiotic.
21. The composition of any one of claims 1 to 20, wherein the biomass or further
- 10 biomass is from the Plantae or Fungi Kingdom.
22. The composition of claim 21, wherein the Plantae is selected from: *Brassicaceae*, *Musaceae*, *Convolvulaceae*, *Cannabis*, *Asparagaceae*, *Arecaceae*, *Myrtaceae*, *Rosaceae*, *Ericaceae*, *Saxifragaceae*, *Cucurbitaceae*, *Nightshade*, *Capparaceae*,
- 15 *Adoxaceae*, *Vitaceae*, *Rutaceae*, *Actinidiaceae*, *Sapindaceae*, *Anacardiaceae*, *Moraceae*, *Oleaceae*, *Cactaceae*, *Passifloraceae*, *Bromeliaceae*, *Cactaceae*, *Lythraceae*, *Polygonaceae*, *Cucurbitaceae*, *Oxalidaceae*, *Caesalpinioideae*, *Compositae*, *Amaranthaceae*, *Chenopodiaceae*, *Malvaceae*, *Amarylidaceae*, *Fabaceae*, *Arecaceae* and *Poaceae*.
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23. The composition of claim 22, wherein the Plantae is *Brassicaceae*.
24. The composition of claim 23, wherein when the Plantae is:
- 25 i) *Brassicaceae* the *Brassicaceae* is broccoli;
- ii) *Musaceae* the *Musaceae* is green banana; and
- iii) *Convolvulaceae* the *Convolvulaceae* is sweet potato.
25. The composition of any one of claims 1 to 24, wherein the composition comprises one or more or all of:
- 30 i) at least one serving of vegetable,
- ii) at least one serving of fruit,
- iii) at least one serving of omega-3,
- iv) at least one serving of omega-6,
- v) at least one serving of omega-9, and
- 35 vi) at least one serving of probiotic.

26. The composition of any one of claims 1 to 25, wherein the composition increases the gastrointestinal level of one or more short chain fatty acid/s (SCFA) in a subject.

5 27. The composition of claim 26, wherein the SCFA is selected from one or more or all of: butyrate (butanoate), propionate (propanoate), acetate (ethanoate), formate (methanoate), isobutyrate (2-Methylpropanoate), valerate (pentanoate), isovalerate (3-methylbutanoate), caproate (hexanoate), formic acid (methanoic acid), acetic acid (ethanoic acid), propionic acid (propanoic acid), butyric acid (butanoic acid), isobutyric
10 acid (2-methylpropanoic acid), valeric acid (pentanoic acid), isovaleric acid (3-methylbutanoic acid), and caproic acid (hexanoic acid).

28. The composition of claim 26 or claim 27, wherein the SCFA is selected from one or more or all of: butyrate, propionate and acetate.

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29. The composition of any one of claims 1 to 28, wherein the composition increases the gastrointestinal level of one or more of:

i) lactic acid bacteria,

ii) a bacteria that produces one or more SCFA; and

20 iii) a bacteria that assists with the production of one or more SCFA.

30. The composition of any one of claims 1 to 29, wherein the composition comprises about 50% to about 90%, or about 60% to about 80%, or about 70% to about 80%, biomass.

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31. The composition of any one of claims 1 to 30, wherein the composition comprises about 1×10^6 CFU/g to about 1×10^{12} CFU/g, or about 1×10^7 CFU/g to about 1×10^{11} CFU/g, about 1×10^8 CFU/g to about 1×10^{10} CFU/g, and 1×10^9 CFU/g to about 1×10^{10} CFU/g, probiotic.

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32. The composition of any one of claims 1 to 31, wherein the composition comprises about 5% to about 50%, or about 10% to about 45%, or about 10% to about 40%, or about 15% to about 30%, or about 20% to about 30% w/w, oil.

33. The composition of any one of claims 1 to 32, wherein the composition increases the gastrointestinal level of one or more bacteria selected from: *Colinsella*, *Bacillus*, *Lactobacillus*, *Lachnospira*, *Faecalibacterium*, *Dialister* and *Veillonella* in a subject.
- 5 34. The composition of any one of claims 1 to 33, wherein the composition decreases the gastrointestinal level of one or more or all of: *Bacteroides*, *Parabacteroides*, *Paraprevotella*, *Turicibacter*, *Christensenellaceae*, some members of Family *Clostridiales*, *Clostridium*, some members of Family *Lachnospiraceae*, *Dorea*, *Roseburia*, some members of the Family *Ruminococcaceae*, *Oscillospira*,
10 *Ruminococcus*, some members of the Family *Erysipelotrichaceae*, *Klebsiella* and *Trabulsiella* in a subject.
35. A method of producing a powder composition, the method comprising
i) producing an aqueous mixture comprising
15 a) protein and carbohydrate from a non-fermented biomass from a single species of organism, and
b) a probiotic, and
ii) forming, from the mixture, a powder comprising the probiotic entrapped or encapsulated in a matrix comprising the protein and the carbohydrate.
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36. The method of claim 35, further comprising adding oil to the aqueous mixture.
37. The method of claim 35 or claim 36, wherein the method comprises adding protein and carbohydrate from at least one further non-fermented biomass from a single
25 species of organism.
38. The method of any one of claims 35 to 37, further comprising pre-treating the biomass.
- 30 39. The method of claim 38, wherein pre-treating comprises one or more of:
i) heating;
ii) macerating;
iii) microwaving;
iv) exposure to low frequency sound waves (ultrasound);
35 v) pulse electric field processing;

- vi) static high pressure;
vii) extrusion;
viii) enzyme treatment;
ix) an extraction or separation process; and
5 x) drying.

40. The method of any one of claims 35 to 39, wherein the composition is adjusted to a pH of about 4.5 to about 7.5, or a pH of about 5 to about 7, or a pH of about 5.5. to about 6.8, or a pH of about 6 to about 6.8, or a pH of about 6.8.

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41. A product comprising the composition of any one of claims 1 to 34, or produced by the method of any one of claims 35 to 40.

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42. The product of claim 41, wherein the product is synbiotic.

43. The product of claim 41 or claim 42, wherein the product comprises an isothiocyanate and/or glucosinolate.

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44. The product of any one of claims 41 to 43 which is a cream, gel tablet, liquid, pill, powder or extruded product.

45. The product of claim 44, wherein the product is a powder.

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46. The product of claim 45, wherein the powder has an induction period of about 10 to about 300 hours, when measured at 80°C and a 5 bar initial oxygen pressure.

47. The product of any one of claims 41 to 46, wherein the product is a food, food ingredient or supplement.

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48. The product of any one of claims 41 to 47, wherein the product comprises an omega 3 polyunsaturated fatty acid.

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49. The product of any one of claims 41 to 48, wherein the product is selected from:
i) an animal feed,
ii) feed ingredient,

- iii) supplement
- iv) an aquaculture feed,
- v) aquaculture feed ingredient, and
- vi) aquaculture supplement.

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50. The product of any one of claims 41 to 49, wherein the product does not comprise a dairy and/or an animal material.

51. A method of promoting health in a subject, comprising administering to the subject a composition of any one of claims 1 to 34, or product of any one of claims 35 to 40.

52. The method of claim 51, wherein the composition or product increases the gastrointestinal level of one or more short chain fatty acid/s (SCFA) in the subject.

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53. The method of claim 52, wherein the SCFA is selected from one or more or all of: butyrate (butanoate), propionate (propanoate), acetate (ethanoate), formate (methanoate), isobutyrate (2-Methylpropanoate), valerate (pentanoate), isovalerate (3-methylbutanoate), caproate (hexanoate), formic acid (methanoic acid), acetic acid (ethanoic acid), propionic acid (propanoic acid), butyric acid (butanoic acid), isobutyric acid (2-methylpropanoic acid), valeric acid (pentanoic acid), isovaleric acid (3-methylbutanoic acid), and caproic acid (hexanoic acid).

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54. The method of claim 52 or claim 53, wherein the SCFA is selected from one or more or all of: butyrate, propionate and acetate.

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55. The method of any one of claims 51 to 54, wherein promoting health comprises promoting one or more of: gut health, immune system health, cardiovascular health, central nervous system function, cognition, metabolic health, nutrient absorption, nutrient utilisation, reducing acidosis, daily increase in body weight, an increase in total body weight, resistance to pathogen colonisation, skeletal health, liver health, blood sugar control and skin health.

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56. The method of any one of claims 51 to 55, wherein promoting health comprises treating or preventing one or more symptoms of a condition selected from: diabetes, inflammation, metabolic dysfunction, asthma, allergy and cancer.
- 5 57. The method of claim 56, wherein promoting gut health comprises reducing or preventing one or more symptoms of a gut health associated condition selected from one or more of: irritable bowel syndrome, inflammatory bowel disease, Crohn's disease, colorectal cancer, gut leakiness, non-alcoholic fatty liver disease, metabolic syndrome, obesity, small intestinal bacterial overgrowth (SIBO), gastroenteritis, gut microbial
10 dysbiosis, reduced gut microbial diversity, antibiotic treatment, post-surgery recovery, food intolerance, diarrhea, gastritis, diverticulitis, flatulence, constipation, functional gut disorders and functional gastrointestinal and motility disorders.
58. The method of any one of claims 51 to 57, wherein promoting health comprises
15 promoting health of the gut microbiome in a subject.
59. The method of claim 58, wherein promoting health of the gut microbiome comprises one or more of:
- i) increasing the level and/or activity of one or more beneficial bacteria,
 - 20 ii) decreasing or maintaining the level and/or activity of one or more non-beneficial bacteria,
 - iii) increasing the resistance of the gut microbiome,
 - iv) increasing the resilience of the gut microbiome,
 - v) increasing the diversity of the gut microbiome,
 - 25 vi) reducing gut leakiness, and
 - vii) increasing the production of one or more SCFA.
60. The method of claim 59, wherein the beneficial bacteria is lactic acid bacteria and/or a bacteria that produces one or more SCFA.
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61. The method of claim 59, wherein the non-beneficial bacteria is selected from a pathogenic *Bacteroides* or *Parabacteriodes*.
62. The method of any one of claims 51 to 61, wherein promoting health of the gut
35 microbiome comprises increasing the gastrointestinal level of one or more bacteria

selected from: *Colinsella*, *Bacillus*, *Lactobacillus*, *Lachnospira*, *Faecalibacterium*, *Dialister* and *Veillonella* in a subject.

63. The method of any one of claims 51 to 62, wherein promoting health of the gut microbiome decreasing the gastrointestinal level of one or more or all of: *Bacteroides*,
5 *Parabacteroides*, *Paraprevotella*, *Turicibacter*, *Christensenellaceae*, some members of *Family Clostridiales*, *Clostridium*, some members of Family *Lachnospiraceae*, *Dorea*, *Roseburia*, some members of the Family *Ruminococcaceae*, *Oscillospira*, *Ruminococcus*, some members of the Family *Erysipelotrichaceae*, *Klebsiella* and
10 *Trabulsiella* in a subject.

64. The method of any one of claims 51 to 63, wherein the subject is an animal.

65. The method of any one of claims 51 to 63, wherein the subject is a human.
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66. The method of any one of claims 51 to 64, wherein the subject is livestock or a companion animal.

67. The method of claim 66, wherein the livestock is selected from a: sheep, cow,
20 goat, chicken, turkey, horse, donkey, pig, fish, prawn and shrimp.

68. A method of promoting the health of the gut microbiome in a subject, comprising administering to the subject the composition of any one of claims 1 to 34, or product of any one of claims 35 to 40.
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69. A method of treating and/or preventing microbial dysbiosis in the gastrointestinal tract of a subject, comprising administering to the subject the composition of any one of claims 1 to 34, or product of any one of claims 35 to 40.

70. A method of treating and/or preventing inflammation in a subject, comprising administering to the subject the composition of any one of claims 1 to 34, or product of any one of claims 35 to 40.
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71. A method of treating and/or preventing diabetes in a subject, comprising administering to the subject the composition of any one of claims 1 to 34, or product of any one of claims 35 to 40.
- 5 72. A method of promoting growth or feed efficacy in livestock comprising administering to a livestock the composition of any one of claims 1 to 34, or the product of any one of claims 35 to 40.
73. A method of improving the quality of livestock derived products comprising
10 administering to a livestock the composition of any one of claims 1 to 34, or the product of any one of claims 35 to 40.
74. The method of claim 73, wherein the livestock derived product is milk, meat or
15 eggs.
75. Use of a composition of any one of claims 1 to 34, or product of any one of claims
35 to 40 in the manufacture of a medicament for promoting health in a subject.
76. Use of a composition of any one of claims 1 to 34, or product of any one of claims
20 35 to 40 in the manufacture of a medicament for promoting health of the gut microbiome in a subject.
77. Use of a composition of any one of claims 1 to 34, or product of any one of claims
25 35 to 40 in the manufacture of a medicament for treating and/or preventing microbial dysbiosis in the gastrointestinal tract of a subject.
78. Use of a composition of any one of claims 1 to 34, or product of any one of claims
30 35 to 40 in the manufacture of a medicament for treating and/or preventing inflammation in a subject.
79. Use of a composition of any one of claims 1 to 34, or product of any one of claims
35 to 40 in the manufacture of a medicament for treating and/or preventing diabetes in a
subject.

80. A pharmaceutical composition comprising a composition of any one of claims 1 to 34, or product of any one of claims 35 to 40 for use in promoting health in a subject.
- 5 81. A pharmaceutical composition comprising a composition of any one of claims 1 to 34, or product of any one of claims 35 to 40 for use in promoting health of the gut microbiome in a subject.
- 10 82. A pharmaceutical composition comprising a composition of any one of claims 1 to 34, or product of any one of claims 35 to 40 for treating and/or preventing microbial dysbiosis in the gastrointestinal tract of a subject.
- 15 83. A pharmaceutical composition comprising a composition of any one of claims 1 to 34, or product of any one of claims 35 to 40 for treating and/or preventing inflammation in a subject.
- 20 84. A pharmaceutical composition comprising a composition of any one of claims 1 to 34, or product of any one of claims 35 to 40 for treating and/or preventing diabetes in a subject.
85. The method or composition of any one of claims 68 to 84, wherein the composition or product is administered enterally.
86. The method or composition of claim 85, wherein administration is oral or rectal.
- 25 87. The method or composition of any one of claims 68 to 85, wherein the composition or product is administered topically.
- 30 88. Faecal microbiota suitable for transplantation into a subject, wherein the faecal microbiota has been isolated from a subject administered a composition of any one of claims 1 to 34, or a product of any one of claims 35 to 40.