

CLAIMS

What is claimed is:

1. A protein-enriched pongamia ingredient, comprising at least 40% of pongamia proteins on a dry weight basis,

wherein the ingredient has: (i) less than 500 ppm of karanjin; or (ii) less than 500 ppm of pongamol; or (iii) less than 500 ppm of karanjin and pongamol combined; and

wherein the ingredient has less than or equal to 40% of carbohydrates on a dry weight basis.

2. The ingredient of claim 1, wherein the ingredient has between 40% and 70% of pongamia proteins on a dry weight basis.

3. The ingredient of claim 1, wherein the ingredient is a pongamia protein concentrate.

4. The ingredient of claim 1, comprising at least 70% of pongamia proteins on a dry weight basis,

wherein the ingredient has: (i) less than 500 ppm of karanjin; or (ii) less than 500 ppm of pongamol; or (iii) less than 500 ppm of karanjin and pongamol combined; and

wherein the ingredient has less than or equal to 20% of carbohydrates on a dry weight basis.

5. The ingredient of claim 4, wherein the ingredient has between 70% and 90% of pongamia proteins on a dry weight basis.

6. The ingredient of claim 5, wherein the ingredient is a pongamia protein isolate.

7. The ingredient of any one of claims 1 to 6, wherein the ingredient is derived from pongamia meal, wherein the protein-enriched pongamia ingredient has at least 1.25 times greater pongamia protein content than the pongamia meal.

8. The ingredient of any one of claims 1 to 7, wherein the ingredient has less than 5% of fat on a dry weight basis.

9. The ingredient of any one of claims 1 to 8, wherein the ingredient has less than 2% of fat on a dry weight basis.

10. The ingredient of any one of claims 1 to 9, wherein the ingredient has a relative amino acid profile that includes at least 15% glutamic acid, at least 12% aspartic acid, at least 9% leucine, at least 8% lysine, at least 6% phenylalanine, or any combination thereof.
11. The ingredient of any one of claims 1 to 10, wherein the at least 35% of the proteins present in the ingredient are soluble in water at a pH of at least pH 6.
12. The ingredient of any one of claims 1 to 11, wherein the ingredient has a viscosity of at least 2 mPa*s at a shear rate of 100 s⁻¹.
13. The ingredient of any one of claims 1 to 12, wherein the ingredient, when emulsified, produces an emulsion having an average droplet size of at least 1 µm.
14. The ingredient of any one of claims 1 to 13, wherein the ingredient has a protein digestibility-corrected amino acid score of at least 0.7.
15. The ingredient of any one of claims 1 to 14, wherein the ingredient has an average molecular weight of protein between 10,000 Daltons and 250,000 Daltons.
16. The ingredient of any one of claims 1 to 15, wherein the ingredient comprises seed storage proteins, and wherein 30-40% of the proteins present are proteins having a molecular weight of between 45 kDa and 70 kDa, as determined by SDS-PAGE.
17. The ingredient of claim 16, wherein the ingredient further comprises seed storage proteins having molecular weight of 170-250 kDa, 115-160 kDa, 45-70 kDa, 19-25 kDa, 14-17 kDa, or 10-13 kDa, or any combinations thereof.
18. The ingredient of any one of claims 1 to 17, wherein the ingredient has:
 - (i) a viscosity of between 2 mPa*s and 100 mPa*s at a shear rate of 100 s⁻¹;
 - (ii) a foaming capacity of between 100% and 200% of volume of 0.1% protein solution;
 - (iii) a bulk density of at least 0.2 g/cm³;
 - (iv) a protein solubility of at least 35% at pH 7;
 - (v) a median emulsion droplet size of less than or equal to 5 µm;

- (vi) a median emulsion droplet size of less than or equal to 5 μm after 7 days of storage;
- (vi) a water-holding capacity of at least 1.5 g water per gram of protein-enriched pongamia ingredient;
- (vii) an oil-holding capacity of at least 1.5 g oil per gram of protein-enriched pongamia ingredient;
- (viii) a minimum gelling concentration of at least 10 g protein-enriched pongamia ingredient per 100 grams;
- (ix) a powder dispersibility of at least 10%; or
- (x) a neutral, non-bitter taste;

or any combinations of (i)- (x) thereof.

19. The ingredient of claim 18, wherein the ingredient has:

- (i) a viscosity of between 2 mPa*s and 100 mPa*s at a shear rate of 100 s^{-1} ;
- (ii) a foaming capacity of between 100% and 200% of volume of 0.1% w/v pongamia protein solution;
- (iii) a bulk density of at least 0.2 g/cm^3 ;
- (iv) a protein solubility of at least 35% at pH 7;
- (v) a median emulsion droplet size of less than or equal to 5 μm ;
- (vi) a median emulsion droplet size of less than or equal to 5 μm after 7 days of storage;
- (vii) a neutral, non-bitter taste;

or any combinations of (i)-(vii) thereof.

20. The ingredient of claim 18, wherein the ingredient has:

- (i) a viscosity of between 2 mPa*s and 100 mPa*s at a shear rate of 100 s^{-1} ;

- (ii) a foaming capacity of between 100% and 200% of volume of 0.1% w/v protein solution;
 - (iii) a bulk density of at least 0.2 g/cm³;
 - (iv) a protein solubility of at least 35% at pH 7;
 - (v) a median emulsion droplet size of less than or equal to 5 µm;
 - (vi) a median emulsion droplet size of less than or equal to 5 µm after 7 days of storage;
 - (vii) a water-holding capacity of at least 1.5 g water per gram of protein-enriched pongamia ingredient;
 - (viii) a minimum gelling concentration of at least 10 g protein-enriched pongamia ingredient per 100 grams; or
 - (ix) a neutral, non-bitter taste or
- or any combination of (i)- (x) thereof.

21. The ingredient of claim 18, wherein the ingredient has:

- (i) a bulk density of at least 0.2 g/cm³;
 - (ii) a protein solubility of at least 35% at pH 7;
 - (iii) a water-holding capacity of at least 1.5 g water per gram of protein-enriched pongamia ingredient;
 - (iv) an oil-holding capacity of at least 1.5 g oil per gram of protein-enriched pongamia ingredient;
 - (v) a minimum gelling concentration of at least 10 g protein-enriched pongamia ingredient per 100 grams; or
 - (vi) a neutral, non-bitter taste;
- or any combination of (i)- (vi) thereof.

22. The ingredient of claim 18, wherein the ingredient has:
- (i) a foaming capacity of between 100% and 200% of volume of 0.1% w/v protein solution;
 - (ii) a minimum gelling concentration of at least 7 g protein-enriched pongamia ingredient per 100 grams; or
 - (iii) a neutral, non-bitter taste;
- or any combination of (i)- (iii) thereof.
23. A method of producing a protein-enriched pongamia composition, comprising:
- preparing an aqueous slurry of pongamia meal, wherein the pongamia meal is defatted and debittered and has (i) less than 500 ppm of karanjin; or (ii) less than 500 ppm of pongamol; or (iii) less than 500 ppm of karanjin and pongamol combined;
 - adjusting the pH of the aqueous slurry to a pH between 6 and 10;
 - separating the slurry into a protein liquid fraction and an insoluble wet cake fraction;
 - neutralizing, concentrating and/or pasteurizing the protein liquid fraction; and
 - drying the protein liquid fraction to provide a protein-enriched pongamia composition.
24. The method of claim 23, wherein the protein-enriched pongamia composition comprises at least 50% of pongamia proteins on a dry weight basis.
25. A method of producing a protein-enriched pongamia ingredient, comprising:
- preparing an aqueous slurry of pongamia meal, wherein the pongamia meal is defatted and debittered and has (i) less than 500 ppm of karanjin; or (ii) less than 500 ppm of pongamol; or (iii) less than 500 ppm of karanjin and pongamol combined;
 - adjusting the pH of the aqueous slurry to a pH between 6 and 10,
 - separating the slurry into a protein liquid fraction and an insoluble wet cake fraction;
 - precipitating at least a portion of pongamia protein from the protein liquid fraction to obtain purified pongamia protein solids;
 - neutralizing and pasteurizing the purified pongamia protein solids; and

drying the purified pongamia protein solids to provide a protein-enriched pongamia ingredient.

26. The method of claim 25, further comprising washing the pongamia protein solids prior to drying.

27. The method of claim 25 or 26, wherein the precipitation step is performed by isoelectric precipitation.

28. The method of any one of claims 25 to 27, wherein the protein-enriched pongamia ingredient comprises at least 70% of pongamia proteins on a dry weight basis.

29. The method of any one of claims 25 to 28, further comprising:

dehulling pongamia beans to produce dehulled pongamia beans; and
pressing the dehulled pongamia beans to remove at least a portion of free oil in the pongamia beans to produce the pongamia meal, wherein the pongamia meal has a reduced fat content.

30. The method of claim 29, further comprising grinding the pongamia meal.

31. The method of any one of claims 25 to 30, further comprising:

dehulling pongamia beans to produce dehulled pongamia beans;
pressing the dehulled pongamia beans to remove at least a portion of free oil in the pongamia beans to produce a reduced fat pongamia meal; and
combining the reduced fat pongamia meal with solvent to produce the pongamia meal, wherein the pongamia meal is defatted and debittered.

32. The method of claim 31, further comprising grinding the reduced fat pongamia meal prior to combining with solvent.

33. The method of claim 31 or claim 32, wherein the solvent comprises ethyl acetate, ethyl alcohol, or a combination thereof.

34. A method of producing a protein-enriched pongamia ingredient, comprising:

preparing an aqueous slurry of pongamia meal;
adjusting the pH of the aqueous slurry to a pH between 6 and 10,

separating the slurry into a protein liquid fraction and an insoluble wet cake fraction;
passing the protein liquid fraction through a membrane system to obtain a retentate comprising pongamia protein;

optionally washing, neutralizing and/or pasteurizing the retentate; and
drying the retentate to provide a protein-enriched pongamia ingredient.

35. The method of claim 34, wherein the protein-enriched pongamia ingredient comprises at least 70% of pongamia proteins on a dry weight basis.

36. The method of claim 34 or claim 35, further comprising:

dehulling pongamia beans to produce dehulled pongamia beans; and
pressing the dehulled pongamia beans to remove at least a portion of free oil in the pongamia beans to produce the pongamia meal, wherein the pongamia meal has a reduced fat content.

37. The method of claim 36, further comprising grinding the pongamia meal.

38. The method of any one of claims 34 to 36, further comprising:

dehulling pongamia beans to produce dehulled pongamia beans;
pressing the dehulled pongamia beans to remove at least a portion of free oil in the pongamia beans to produce a reduced fat pongamia meal; and
combining the reduced fat pongamia meal with solvent to produce the pongamia meal, wherein the pongamia meal is defatted and debittered.

39. The method of claim 38, further comprising grinding the reduced fat pongamia meal prior to combining with solvent.

40. A method of producing a protein-enriched pongamia composition, comprising:

preparing an aqueous slurry of pongamia meal;
adjusting the pH of the aqueous slurry to a pH between 4 and 5 to obtain pongamia protein solids;
washing, neutralizing, and pasteurizing purified protein solids; and
drying the purified pongamia protein solids to provide a protein-enriched pongamia composition.

41. A protein-enriched pongamia ingredient produced according the method of any one of claims 23 to 40.
42. A food product, a beverage product, a dietary supplement product or other product, comprising: the protein-enriched pongamia ingredient of any one of claims 1 to 22 and 41.
43. The product of claim 42, wherein the product is a baked good, a protein supplement, a protein bar, or a non-dairy beverage.
44. The product of claim 42, wherein the product is a medical food, an infant formula, a cosmetic or a pharmaceutical product.
45. The product of claim 42, wherein the product is a beverage product, a dairy-product substitute, a meat substitute product, or an egg substitute.
46. The product of claim 45, wherein the beverage product is a fruit smoothie, a meal replacement beverage, a protein drink, an instant shake.
47. The product of any one of claims 42, 45 and 46, wherein the product is a beverage product comprising at least 20 g of protein-enriched pongamia ingredient per serving.
48. The product of claim 45, wherein the dairy-product substitute is a non-dairy milk, non-dairy cheese, non-dairy coffee whitener or creamer, non-dairy yogurt, non-dairy Greek yogurt, non-dairy drinkable yogurt.