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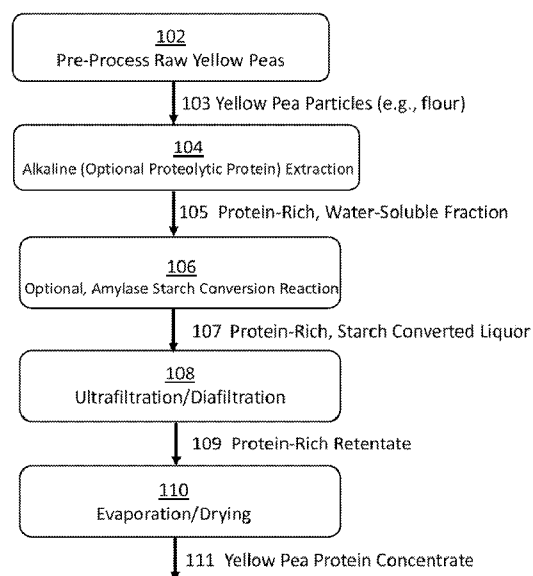


FIG. 1

(57) Abstract: Food-grade pulse protein concentrates prepared from various pulses and flours derived therefrom are provided. Also provided are method of making the concentrates and beverages and foodstuffs that include the concentrates. The pulse protein concentrates are characterized by a high protein content, high digestibility, and complete essential amino acid profile.

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AMENDED CLAIMS

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WHAT IS CLAIMED IS:

1. A method for making a plant protein composition from pulse particles, the method comprising: (a) conducting an alkaline extraction on an aqueous slurry of the pulse particles; (b) removing water-insoluble proteins and other water-insoluble components from the aqueous slurry to provide a water-soluble, protein-rich liquid fraction; (c) separating water-soluble proteins in the protein-rich liquid fraction from water-soluble lower molecular weight peptides and water-soluble non-proteins in the protein-rich liquid fraction via ultrafiltration using an ultrafiltration membrane that concentrates the albumin proteins to provide a protein-rich retentate; and (d) removing water from the protein-rich retentate to provide a dry plant protein composition.
2. The method of claim 1, wherein the alkaline extraction is conducted at a pH in the range from 7.5 to 9.5 for a duration sufficient to provide the plant proteins with a degree of hydrolysis of greater than zero and less than 15.
3. The method of claim 2, wherein the alkaline extraction is conducted at a pH in the range from 7.5 to 9.5 for a duration sufficient to provide the plant proteins with a degree of hydrolysis of greater than 1, but no greater than 12.
4. The method of claim 1, wherein the aqueous slurry comprises from 5 wt.% to 12 wt.% of the pulse particles, the pulse particles having a maximum particles size of less than 200 microns; and the water-soluble, protein-rich liquid has an insoluble solids content of no greater than 2.0 vol.%.
5. The method of claim 1, wherein the plant protein composition has a plant protein concentration of at least 60%, based on a dry weight basis.
6. The method of claim 1, wherein the plant protein composition has a plant protein concentration of at least 70%, based on a dry weight basis.
7. The method of claim 1, wherein the plant protein composition has a plant protein concentration of at least 80%, based on a dry weight basis.

8. The method of claim 1, wherein the alkaline extraction is an alkaline proteolytic extraction.
9. The method of claim 1, wherein the ultrafiltration membrane has a molecular weight cutoff of 5 kDa or smaller.
10. The method of claim 1, wherein the pulse particles comprise yellow pea particles and the plant protein comprises yellow pea protein.
11. The method of claim 1, wherein the pulse particles comprise chickpea particles and the plant protein comprises chickpea protein.
12. The method of claim 1, wherein the pulse particles are selected from lentil particles, fava bean particles, and mung bean particles and the plant protein is selected from lentil protein, fava bean protein, and mung bean protein.
13. The method of claim 1, wherein the dry plant protein has a solubility of at least 95%.
14. The method of claim 1, further comprising performing an amylase carbohydrate reaction on the water-soluble, protein-rich liquid fraction prior to separating the water-soluble proteins in the protein-rich liquid fraction from the water-soluble lower molecular weight peptides and water-soluble non-proteins.
15. The method of claim 14, wherein the amylase carbohydrate reaction is carried out on the water-soluble, protein-rich liquid at a pH in the range from 4.0 to 7.0 and results in the conversion of starch, dextrans, maltodextrins, and complex sugars into smaller fragments that pass through into a permeate fraction of the ultrafiltration process.
16. A food product comprising:
 - a beverage or foodstuff, other than yellow peas; and
 - a yellow pea protein concentrate combined with the beverage or foodstuff,wherein the yellow pea protein concentrate has a yellow pea protein concentration of at least 70%, based on dry weight, greater than or equal to 27 milligrams of sulfur-containing

amino acids per gram of protein, an *in vitro* Protein Digestibility of at least 0.98, and a PDCAAS value of at least 0.98 for children ages 6 months to 3 years.

17. The food product of claim 26, wherein the food product is free of plant proteins other than yellow pea proteins.

18. The food product of claim 16, wherein the yellow pea protein concentrate has a yellow pea protein concentration of at least 80%, based on dry weight.

19. The food product of claim 16, wherein the food product is a non-dairy liquid beverage, a non-dairy beverage powder, and/or a food product comprising active yogurt cultures.

20. The food product of claim 16, wherein the yellow pea protein concentrate has a DH value of at least 1, but less than 15.

21. The food product of claim 22, wherein the yellow pea protein concentrate comprises albumin protein fragments comprising cleaved tertiary structures and having molecular weights in the range from 5 kDa to 40 kDa.

22. The food product of claim 16, wherein the yellow pea protein concentrate has an *in vitro* Protein Digestibility of 1.00, and a PDCAAS value of 1.00 for children ages 6 months to 3 years.

23. A yellow pea protein concentrate comprising yellow pea proteins, wherein the yellow pea protein concentrate is free of proteins other than yellow pea proteins and has a yellow pea protein concentration of at least 70%, based on dry weight, a complete amino acid profile for children ages 6 months to 3 years, greater than or equal to 27 milligrams of sulfur-containing amino acids per gram of protein, an *in vitro* Protein Digestibility of at least 0.98, and a PDCAAS value of at least 0.98 for children ages 6 months to 3 years.

24. The yellow pea protein concentrate of claim 23 having a yellow pea protein concentration of at least 80%, based on dry weight.

25. The yellow pea protein concentrate of claim 23 having a DH value of greater than 1, but less than 15.

26. The yellow pea protein concentrate of claim 23 having an *in vitro* Protein Digestibility of 1.00, and a PDCAAS value of 1.00 for children ages 6 months to 3 years.

27. The yellow pea protein concentrate of claim 23, comprising albumin protein fragments comprising cleaved tertiary structures and having molecular weights in the range from 5 kDa to 40 kDa.

28. The yellow pea protein concentrate of claim 27, wherein the yellow pea proteins are partially hydrolyzed.

29. A chickpea protein concentrate comprising chickpea proteins, wherein the chickpea protein concentrate is free of proteins other than chickpea proteins and has a chickpea protein concentration of at least 60%, based on dry weight, a complete amino acid profile for adults, greater than or equal to 22 milligrams of sulfur-containing amino acids per gram of protein, an *in vitro* Protein Digestibility of at least 0.97, and a PDCAAS value of at least 0.97 for adults.

30. A chickpea protein concentrate comprising chickpea proteins, wherein the chickpea protein is free of protein other than chickpea proteins and has a chickpea protein concentration of at least 60%, based on dry weight, a complete amino acid profile for children ages 6 month through adult, greater than or equal to 27 milligrams of sulfur containing amino acids per gram of protein, an *in vitro* Protein Digestibility of at least 0.97, and a PDCAAS value of at least 0.97 for children aged 6 months through adult.

31. A food product comprising:
a beverage or foodstuff, other than chickpeas; and
the chickpea protein concentrate of claim 29.

32. A food product comprising:
a beverage or foodstuff, other than chickpeas; and
the chickpea protein concentrate of claim 30.

33. A lentil protein concentrate comprising lentil proteins, wherein the lentil protein concentrate is free of proteins other than lentil proteins and has a lentil protein concentration of at least 60%, based on dry weight, a complete amino acid profile for adults, greater than or equal to 22 milligrams of sulfur-containing amino acids per gram of protein, an *in vitro* Protein Digestibility of at least 0.97, and a PDCAAS value of at least 0.97 for adults.

34. A food product comprising:
a beverage or foodstuff, other than lentils; and
the lentil protein concentrate of claim 33.

35. A fava bean protein concentrate comprising fava bean proteins, wherein the fava bean protein concentrate is free of proteins other than fava bean proteins and has a fava bean protein concentration of at least 60%, based on dry weight, a complete amino acid profile for adults, greater than or equal to 22 milligrams of sulfur-containing amino acids per gram of protein, an *in vitro* Protein Digestibility of at least 0.97, and a PDCAAS value of at least 0.97 for adults.

36. A food product comprising:
a beverage or foodstuff, other than fava beans; and
the fava bean protein concentrate of claim 35.

37. A mung bean protein concentrate comprising mung bean proteins, wherein the mung bean protein concentrate is free of proteins other than mung bean proteins and has a mung bean protein concentration of at least 60%, based on dry weight, a complete amino acid profile for adults, greater than or equal to 22 milligrams of sulfur-containing amino acids per gram of protein, an *in vitro* Protein Digestibility of at least 0.97, and a PDCAAS value of at least 0.97 for adults.

38. A food product comprising:
a beverage or foodstuff, other than mung beans; and
the mung bean protein concentrate of claim 37.

39. A method for making a pulse protein composition comprising albumin proteins from pulse particles, the method comprising:
- separating an aqueous slurry of the pulse particles into a soluble fraction in which water-soluble pulse proteins are concentrated and an insoluble fraction in which water-insoluble pulse proteins are concentrated;
 - conducting an acid precipitation on the soluble fraction to separate the water-soluble pulse proteins into curds that comprise precipitated pulse proteins and an acid whey that comprises unprecipitated pulse proteins, including albumin proteins;
 - forming a pulse protein composition by capturing and removing pulse proteins, including albumin proteins, from the acid whey via ultrafiltration; and
 - drying the pulse protein composition.
40. The method of claim 39, further comprising conducting an amylase and glucoamylase carbohydrate reaction on the acid whey prior to capturing and removing pulse proteins from the acid whey.
41. The method of claim 40, wherein the pulse particles are yellow pea particles.
42. The method of claim 39, wherein the ultrafiltration is carried out using an ultrafiltration membrane having a molecular weight cutoff of 5 kDa or smaller.
43. The method of claim 39, wherein the pulse particles are yellow pea particles.
44. The method of claim 39, wherein the pulse particles are selected from chickpea particles, lentil particles, fava bean particles, and mung bean particles.