[0005] The widespread use of pongamia-derived foodstuffs is currently prevented by the absence of methods for preparing pongamia compositions having low levels of karanjin and pongamol while maintaining the high nutritional content (proteins, carbohydrates, etc.) intrinsic to the oilseeds. Existing methods for the removal of these undesirable components in pongamia seedcake and oil are insufficient and often require harsh, destructive conditions that reduce and degrade the nutrients to the point that the nutritional value of pongamia is severely impacted. The lack of methods for producing pongamia compositions having the critical balance of preserved nutritional content and sufficiently low levels of anti-nutrients have precluded the incorporation of pongamia-derived oil on a large enough scale to remain economically feasible.

[0006] Thus, what is desired in the art are commercially viable methods to obtain edible compositions from pongamia oilseeds that retain an optimal nutritional balance, while minimizing components such as karanjin and pongamol.

BRIEF SUMMARY

[0006a] In an aspect of the present disclosure, there is provided a pongamia oil composition, having:

less than or equal to 1000±20 ppm of karanjin and pongamol combined;

less than or equal to 1±0.02% by weight of unsaponifiable matter;

a peroxide value of less than or equal to 5±0.1 meq/kg;

a p-anisidine value of less than or equal to 10±0.2;

less than or equal to 5% trans fatty acids; and

less than or equal to 5000±100 ppm of residual solvent, optionally wherein the composition comprises less than or equal to 1000±20 ppm of residual solvent, wherein residual solvent, if present, is food grade solvent, optionally wherein the residual solvent comprises ethanol,

optionally wherein the karanjin and pongamol concentration is determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition.

[0006b] In another aspect of the present disclosure, there is provide a method for producing a pongamia oil composition, comprising:

mechanically separating dehulled pongamia oilseeds to produce crude pongamia oil and a seedcake that is at least partially deoiled, optionally wherein the crude pongamia oil is mechanically separated pongamia oil, wherein the crude pongamia oil comprises pongamia oil, karanjin, pongamol, other furanoflavonoids, and other unsaponifiable matter; and

extracting the crude pongamia oil with an immiscible solvent, optionally wherein the immiscible solvent comprises ethanol, at an elevated temperature to produce the pongamia oil composition, optionally wherein the elevated temperature is less than the boiling point of the immiscible solvent, optionally wherein the elevated temperature is between 30±0.6 ℃ and 75±1.5 ℃, optionally wherein the crude pongamia oil and the immiscible solvent form a mixture and the mixture is agitated for at least 30±0.6 minutes,

wherein the ratio of solvent to crude pongamia oil is between 1:1 and 20:1, optionally wherein the ratio of solvent to crude pongamia oil is between 1±0.02:1 and 5±0.1:1.

[0006c] In a further aspect of the present disclosure, there is provided a continuous countercurrent method for producing a pongamia oil composition, comprising:

a) mechanically separating dehulled pongamia oilseeds to produce crude pongamia oil and a seedcake that is at least partially deoiled, optionally wherein the crude pongamia oil is mechanically separated pongamia oil,

wherein the crude pongamia oil comprises pongamia oil, karanjin, pongamol, other furanoflavonoids, and other unsaponifiable matter;

b) separating the crude pongamia oil into a raffinate and a solvent-rich light phase by liquid-liquid extraction using immiscible solvent at an elevated temperature, optionally wherein the elevated temperature is less than the boiling point of the immiscible solvent, optionally wherein the elevated temperature is between 30±0.6 ℃ and 75±1.5 ℃,

wherein the ratio of solvent to crude pongamia oil is between 1:1 and 20:1, optionally wherein the ratio of solvent to crude pongamia oil is between 1±0.02:1 and 5±0.1:1,

wherein the raffinate comprises pongamia oil and residual solvent,

wherein the solvent comprises ethanol, and

wherein the solvent-rich light phase comprises solvent and residual pongamia oil, optionally wherein the continuous liquid-liquid extraction is performed using a forced agitated column, optionally wherein the forced agitated column is a forced agitated trayed column, the

raffinate exits the column at the bottom, and the solvent-rich light phase exits the column at the top;

c) cooling the raffinate to separate the residual solvent from pongamia oil;

d) isolating at least a portion of the pongamia oil in the cooled raffinate to produce the pongamia oil composition,

e) separating at least a portion of the solvent from the solvent-rich light phase, optionally wherein at least a portion of the solvent separated from the solvent-rich light phase is performed in an evaporator,

optionally wherein the solvent is evaporated from the residual pongamia oil under vacuum,

optionally further comprising condensing the solvent, and stripping the solvent of any accumulated water in a stripping column; and

f) combining the isolated solvent with additional crude pongamia oil for liquid-liquid extraction.

[0006d] In another aspect of the present disclosure, there is provided a use of the pongamia oil composition disclosed herein as salad oil, frying oil, sauteeing oil, vinaigrettes, sauces, dressings, fats in meat mimetics, beverages, or blended margarines and other solid fat applications, or any combination thereof.

[0006e] In a further aspect of the present disclosure, there is provided a food or beverage product, comprising the pongamia oil composition disclosed herein, optionally wherein the product is salad oil, frying oil, sauteeing oil, vinaigrettes, sauces, dressings, fats in meat mimetics, beverages, or blended margarines and other solid fat applications.

[0007] In some examples, provided herein are pongamia oil compositions that are edible and non-bitter tasting. Such pongamia oil compositions can serve as useful ingredients in

CLAIMS

What is claimed is:

1. A pongamia oil composition, having:

   less than or equal to 1000±20 ppm of karanjin and pongamol combined;

   less than or equal to 1±0.02% by weight of unsaponifiable matter;

   a peroxide value of less than or equal to 5±0.1 meq/kg;

   a p-anisidine value of less than or equal to 10±0.2;

   less than or equal to 5% trans fatty acids; and

   less than or equal to 5000±100 ppm of residual solvent, optionally wherein the composition comprises less than or equal to 1000±20 ppm of residual solvent, wherein residual solvent, if present, is food grade solvent, optionally wherein the residual solvent comprises ethanol,

   optionally wherein the karanjin and pongamol concentration is determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition.

2. The composition of claim 1, having a furanoflavonoid concentration of less than or equal to 500±10 ppm.

3. The composition of claim 1 or 2, having less than or equal to 150±3 ppm karanjin and/or pongamol.

4. The composition of any one of claims 1 to 3, having:

   less than or equal to 150±3 ppm of karanjin;

   less than or equal to 150±3 ppm of pongamol;

   less than or equal to 1±0.02% by weight of unsaponifiable matter;

   a peroxide value of less than or equal to 5±0.1 meq/kg;

   a p-anisidine value of less than or equal to 5±0.1; and

   less than or equal to 5000±100 ppm of residual solvent, optionally wherein the composition comprises less than or equal to 1000±20 ppm of residual solvent, wherein residual solvent, if present, is food grade solvent, optionally wherein the residual solvent comprises ethanol,

optionally wherein the karanjin and pongamol concentration is determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition.

5. The composition of any one of claims 1 to 4, wherein the composition is liquid at room temperature; and/or
the composition has a viscosity of between 30±0.6 centipoise and 600±12 centipoise as determined at 25℃; and/or
the composition has a solid fat content of between 1±0.02% and 10±0.2% at a temperature of about 5℃; and/or
the composition has a smoke point of at least 195±3.9 ℃.

6. The composition of any one of claims 1 to 5, wherein the composition has less than or equal to 400±8 ppm of tocopherols; and/or
the composition has less than 2500 ppm of sterols; and/or
the composition comprises oleic acid, linoleic acid, palmitic acid, stearic acid, behenic acid, alpha linolenic acid, lignoceric acid, arachidic acid, gondoic acid, oleic acid, vaccenic acid, palmitoleic acid, eicosadienoic acid, linoleic acid, margaric acid, gondoic acid, erucic acid, palmitoleic acid, heptadecenoic acid, or myristic acid, or any isomers thereof, or any combination of the foregoing, optionally wherein the composition comprises at least 40% oleic acid.

7. The composition of any one of claims 1 to 6, wherein the color of the composition is yellow or light yellow as determined by the Lovibond Color - AOCS Scale using a 1-inch cell path, wherein:
when the composition is yellow, the composition has a Lovibond Color Y-value of greater than or equal to 25; and
when the composition is light yellow, the composition has a Lovibond Color Y-value of less than 25.

8. The composition of any one of claims 1 to 7, wherein the composition has one or more sensory attributes selected from the group consisting of: nuttiness, butteriness, grassiness, smoothness, and sweetness, and any combinations thereof, optionally wherein the composition has a ratio of karanjin to pongamol of greater than 1±0.02.

9. The composition of any one of claims 1 to 8, wherein the color of the composition is light yellow and the composition has a Lovibond Color Y-value of less than 25 as determined by the Lovibond Color - AOCS Scale using a 1-inch cell path, optionally wherein the color of the composition is light yellow as determined by the Lovibond Color - AOCS Scale, and wherein the composition comprises less than or equal to 200±4 ppm karanjin and pongamol combined as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition.

10. The composition of any one of claims 1 to 9, wherein the composition has a neutral flavor, optionally wherein the composition has a ratio of karanjin to pongamol of less than or equal to 1.

11. The composition of any one of claims 1 to 10, wherein the composition has:

(i) a free fatty acid content of less than or equal to 1±0.02%;

(ii) less than or equal to 0.1±0.002% of insoluble impurities;

(iii) less than or equal to 25±0.5 ppm of phosphorus;

(iv) less than or equal to 0.1±0.002 ppm of chlorophyll;

(v) a moisture content of less than or equal to 1±0.02%;

(vi) less than or equal to 1±0.02% glycerol;

(vii) less than or equal to 2±0.04% monoglycerides;

(viii) less than or equal to 5±0.1% diglycerides; and

(ix) at least 90±1.8% triglycerides

(x) or any combination of (i)-(ix).

12. A method for producing a pongamia oil composition, comprising:

mechanically separating dehulled pongamia oilseeds to produce crude pongamia oil and a seedcake that is at least partially deoiled, optionally wherein the crude pongamia oil is mechanically separated pongamia oil, wherein the crude pongamia oil comprises pongamia oil, karanjin, pongamol, other furanoflavonoids, and other unsaponifiable matter; and

extracting the crude pongamia oil with an immiscible solvent, optionally wherein the immiscible solvent comprises ethanol, at an elevated temperature to produce the pongamia oil composition, optionally wherein the elevated temperature is less than the boiling point of the immiscible solvent, optionally wherein the elevated temperature is between 30±0.6 ℃ and

75±1.5 ℃, optionally wherein the crude pongamia oil and the immiscible solvent form a mixture and the mixture is agitated for at least 30±0.6 minutes,

wherein the ratio of solvent to crude pongamia oil is between 1:1 and 20:1, optionally wherein the ratio of solvent to crude pongamia oil is between 1±0.02:1 and 5±0.1:1.

13. The method of claim 12, wherein the composition is edible and non-bitter tasting, has less than or equal to 1000±20 ppm of karanjin and pongamol combined as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition; less than or equal to 1±0.02% by weight of unsaponifiable matter; a peroxide value of less than or equal to 5±0.1 meq/kg; and a p-anisidine value of less than or equal to 10±0.2.

14. A continuous countercurrent method for producing a pongamia oil composition, comprising:

a) mechanically separating dehulled pongamia oilseeds to produce crude pongamia oil and a seedcake that is at least partially deoiled, optionally wherein the crude pongamia oil is mechanically separated pongamia oil,

wherein the crude pongamia oil comprises pongamia oil, karanjin, pongamol, other furanoflavonoids, and other unsaponifiable matter;

b) separating the crude pongamia oil into a raffinate and a solvent-rich light phase by liquid-liquid extraction using immiscible solvent at an elevated temperature, optionally wherein the elevated temperature is less than the boiling point of the immiscible solvent, optionally wherein the elevated temperature is between 30±0.6 ℃ and 75±1.5 ℃,

wherein the ratio of solvent to crude pongamia oil is between 1:1 and 20:1, optionally wherein the ratio of solvent to crude pongamia oil is between 1±0.02:1 and 5±0.1:1,

wherein the raffinate comprises pongamia oil and residual solvent,

wherein the solvent comprises ethanol, and

wherein the solvent-rich light phase comprises solvent and residual pongamia oil, optionally wherein the continuous liquid-liquid extraction is performed using a forced agitated column, optionally wherein the forced agitated column is a forced agitated trayed column, the raffinate exits the column at the bottom, and the solvent-rich light phase exits the column at the top;

c) cooling the raffinate to separate the residual solvent from pongamia oil;

d) isolating at least a portion of the pongamia oil in the cooled raffinate to produce the pongamia oil composition,

e) separating at least a portion of the solvent from the solvent-rich light phase, optionally wherein at least a portion of the solvent separated from the solvent-rich light phase is performed in an evaporator,

optionally wherein the solvent is evaporated from the residual pongamia oil under vacuum,

optionally further comprising condensing the solvent, and stripping the solvent of any accumulated water in a stripping column; and

f) combining the isolated solvent with additional crude pongamia oil for liquid-liquid extraction.

15. The method of claim 14, wherein the composition is edible and non-bitter tasting, has less than or equal to 1000±20 ppm of karanjin and pongamol combined as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition; less than or equal to 1±0.02% by weight of unsaponifiable matter; a peroxide value of less than or equal to 5±0.1 meq/kg; and a p-anisidine value of less than or equal to 10±0.2.

16. The method of claim 14 or 15, further comprising isolating the residual pongamia oil in the solvent-rich light phase; and distilling solvent from the isolated residual pongamia oil to produce additional pongamia oil composition.

17. The method of any one of claims 12 to 16, wherein the composition has less than or equal to 5% trans fatty acids.

18. The method of claim 12 or 17, wherein the crude pongamia oil has an initial color, and the pongamia oil composition produced has a final color, wherein the final color of the pongamia oil composition is lighter than the initial color of the crude pongamia oil as determined by the Lovibond Color - AOCS Scale, optionally wherein the initial color is red and/or brown, and the final color is yellow or light yellow as determined by the Lovibond Color - AOCS Scale.

19. The method of any one of claims 12 to 18, wherein the composition has one or more sensory attributes selected from the group consisting of: nuttiness, butteriness, grassiness,

smoothness, and sweetness, and any combinations thereof, and wherein the composition is yellow as determined by the Lovibond Color - AOCS Scale;

or

the pongamia oil composition the composition comprises less than or equal to 200±4 ppm karanjin and pongamol combined as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition; the composition has a neutral flavor, and the composition is light yellow as determined by the Lovibond Color - AOCS Scale.

20. Use of the pongamia oil composition of any one of claims 1 to 11 as salad oil, frying oil, sauteeing oil, vinaigrettes, sauces, dressings, fats in meat mimetics, beverages, or blended margarines and other solid fat applications, or any combination thereof.

21. A food or beverage product, comprising the pongamia oil composition of any one of claims 1 to 11, optionally wherein the product is salad oil, frying oil, sauteeing oil, vinaigrettes, sauces, dressings, fats in meat mimetics, beverages, or blended margarines and other solid fat applications.

22. The product of claim 21, wherein the composition is light yellow as determined by the Lovibond Color - AOCS Scale; the composition comprises less than or equal to 200±4 ppm karanjin and pongamol combined as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition, and the composition has a neutral flavor; or

the pongamia oil composition is yellow as determined by the Lovibond Color - AOCS Scale; the composition comprises less than or equal to 150±3 ppm karanjin and less than or equal to 150±3 ppm pongamol as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition; and the composition has one or more sensory attributes selected from the group consisting of: nuttiness, butteriness, grassiness, smoothness, and sweetness, and any combinations thereof.