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 about 1000 ppm of karanjin and pongamol combined;

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

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

a p-anisidine value of less than or equal to about 10; and

less than or equal to about 25 ppm of residual solvents, 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 provided an analytical method, comprising:

combining pongamia oil with an extraction solvent to provide an extraction mixture, wherein the extraction solvent comprises alkyl ketone, optionally wherein the alkyl ketone is acetone, and wherein the pongamia oil comprises karanjin or pongamol, or both;

sonicating the extraction mixture to produce a sonicated mixture;

separating the sonicated mixture into an extracted pongamia composition and an alkyl ketone extract, wherein the extract comprises karanjin or pongamol, or both; and

measuring the concentration of karanjin or pongamol, or both, present in the extract, optionally wherein the measuring step comprises determining the concentration of karanjin or pongamol, or both, by high performance liquid chromatography with an ultraviolet detector, optionally wherein the ultraviolet detector is a diode array detector.

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

combining crude pongamia oil with non-polar solvent to produce a crude mixture, wherein the non-polar solvent comprises alkane, optionally wherein the non-polar solvent comprises hexane, and wherein the crude pongamia oil comprises pongamia oil and furanoflavonoids, optionally wherein the crude pongamia oil is mechanically separated pongamia oil , and optionally wherein the crude pongamia oil is combined with the non-polar solvent in a ratio between 1:1 and 3:1 (w/v);

eluting the crude mixture through silica gel with the non-polar solvent to separate at least a portion of the furanoflavonoids from the pongamia oil, and to produce a purified mixture comprising pongamia oil and the non-polar solvent; and

removing at least a portion of the non-polar solvent from the purified mixture to produce a pongamia oil composition, wherein the composition has less than or equal to about 1000 ppm of karanjin and pongamol combined as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition; optionally wherein the concentration of karanjin or pongamol, or both, is determined by the method disclosed herein, less than or equal to about 1% by weight of unsaponifiable matter; a peroxide value of less than or equal to about 5 meq/kg; and a p-anisidine value of less than or equal to about 10.

[0006d] In another aspect of the present disclosure, there is provided a pongamia oil composition produced according to the method disclosed herein.

[0006e] In a further 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 ~~aspect~~examples, provided herein are pongamia oil compositions that are edible and non-bitter tasting. Such pongamia oil compositions can serve as useful ingredients in a variety of food and beverage products, and address the substantial unmet need in the industry for emerging plant-based products.

[0008] In certain ~~aspect~~examples, provided are methods for producing pongamia oil compositions using solid-liquid separation. In some ~~embodiment~~examples, the method comprises: combining crude pongamia oil with non-polar solvent to produce a crude mixture; eluting the crude mixture through silica gel with the non-polar solvent to separate at least a portion of the furanoflavonoids present in the crude mixture from the pongamia oil, and to produce a purified mixture that includes pongamia oil and the non-polar solvent; and removing at least a portion of the non-polar solvent from the purified mixture to produce a pongamia oil composition. In some variations, the non-polar solvent comprises alkane.

[0009] The crude pongamia oil contains karanjin and pongamol, and at least a portion of the karanjin and pongamol are adsorbed on the silica gel in the aforementioned method. The adsorbed components may be isolated. In certain ~~embodiment~~examples, the method further comprises: eluting the silica gel with a polar solvent to isolate the karanjin and pongamol. In certain ~~embodiment~~examples, the silica gel is eluted using a stepwise gradient with increasing proportions of

polar solvent in the non-polar solvent to isolate karanjin and pongamol separately. In some variations, the polar solvent comprises alkyl alkanoate.

[0010] In one ~~aspect~~example, provided is a pongamia oil composition produced according to any of the methods described herein. In other ~~aspect~~examples, provided is a pongamia oil composition that is edible and non-bitter tasting.

[0011] In other ~~aspect~~examples, provided are uses of the pongamia oil compositions in food or beverage products. In some variations, the pongamia oil compositions may be used as or in salad oil, frying oil, sauteeing oil, vinaigrettes, sauces, dressings, fats in meat mimetics, beverages, or blended margarines and other solid fat applications.

[0012] In other ~~aspect~~examples, provided is an analytical method to measure the content of karanjin and pongamol that may be present in a pongamia oil sample. In some ~~embodiment~~examples, the method comprises: combining pongamia oil with an extraction solvent to provide an extraction mixture; sonicating the extraction mixture; separating the sonicated mixture into an extracted pongamia composition and an extract that comprises karanjin or pongamol, or both; and measuring the concentration of karanjin or pongamol, or both, present in the extract. In some variations, the extraction solvent comprises alkyl ketone. In some ~~embodiment~~examples, the measuring step involves determining the concentration of karanjin and/or pongamol by high performance liquid chromatography with an ultraviolet detector (*e.g.*, using a HPLC-DAD).

[0013] In one ~~aspect~~example, provided herein is a pongamia oil composition, having: less than or equal to about 1000 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 about 1% by weight of unsaponifiable matter; a peroxide value of less than or equal to about 5 meq/kg; a p-anisidine value of less than or equal to about 10; and less than or equal to about 25 ppm of residual solvents. In some ~~embodiment~~examples, the pongamia oil composition has less than or equal to about 150 ppm of karanjin as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition; less than or equal to about 150 ppm of pongamol as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition; less than or equal to about 1% by weight of unsaponifiable matter; a peroxide value

of less than or equal to about 5 meq/kg; a p-anisidine value of less than or equal to about 5; and less than or equal to about 25 ppm of residual solvents.

[0014] In another ~~aspect~~example, provided herein is a method for producing a pongamia oil composition, comprising: combining crude pongamia oil with non-polar solvent to produce a crude mixture, wherein the non-polar solvent comprises alkane, and wherein the crude pongamia oil comprises pongamia oil and furanoflavonoids; eluting the crude mixture through silica gel with the non-polar solvent to separate at least a portion of the furanoflavonoids from the pongamia oil, and to produce a purified mixture comprising pongamia oil and the non-polar solvent; and removing at least a portion of the non-polar solvent from the purified mixture to produce a pongamia oil composition, wherein the composition has less than or equal to about 1000 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 about 1% by weight of unsaponifiable matter; a peroxide value of less than or equal to about 5 meq/kg; and a p-anisidine value of less than or equal to about 10.

[0015] In other ~~aspect~~examples, provided herein are food or beverage products comprising pongamia oil compositions obtainable by the methods described herein. In some ~~embodiment~~examples, the pongamia oil composition is light yellow as determined by the Lovibond Color - AOCS Scale; the composition comprises less than or equal to about 200 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. In other ~~embodiment~~examples, the pongamia oil composition is yellow as determined by the Lovibond Color - AOCS Scale; the composition comprises less than or equal to about 150 ppm karanjin and less than or equal to about 150 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.

DESCRIPTION OF THE FIGURES

[0016] The present application can be understood by reference to the following description taken in conjunction with the accompanying figures.

CLAIMS

What is claimed is:

1. A pongamia oil composition, having:

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

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

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

a p-anisidine value of less than or equal to about 10; and

less than or equal to about 25 ppm of residual solvents, 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:

less than or equal to about 150 ppm of karanjin;

less than or equal to about 150 ppm of pongamol;

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

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

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

less than or equal to about 25 ppm of residual solvents, optionally wherein the karanjin and pongamol concentration is determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition.

3. The composition of claim 1 or claim 2, wherein the residual solvents comprise a non-polar solvent, optionally wherein the non-polar solvent comprises alkane.

~~4. The composition of any one of claims 1 to 3, wherein the residual solvents comprise a non-polar solvent and wherein the non-polar solvent comprises alkane.~~

~~5.~~4. The composition of any one of claims 1 to ~~4~~3, wherein:

the composition is liquid at room temperature; and/or

the composition has a viscosity of between about 30 centipoise and 600 centipoise as determined at 25°C; and/or

the composition has a solid fat content of between about 1% and about 10% at a temperature of about 5°C; and/or

the composition has a smoke point of at least about 195 °C.

~~6. The composition of any one of claims 1 to 5, wherein the composition has a viscosity of between about 30 centipoise and 600 centipoise as determined at 25°C.~~

~~7. The composition of any one of claims 1 to 6, wherein the composition has a solid fat content of between about 1% and about 10% at a temperature of about 5°C.~~

~~8. The composition of any one of claims 1 to 7, wherein the composition has a smoke point of at least about 195 °C.~~

~~9.~~5. The composition of any one of claims 1 to ~~8~~4, wherein:

the composition has at least 400 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.

~~10. The composition of any one of claims 1 to 9, wherein the composition has less than 2500 ppm of sterols.~~

~~11. The composition of any one of claims 1 to 10 wherein 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.~~

~~12. The composition of claim 11, wherein the composition comprises at least 40% oleic acid.~~

~~13.~~6. The composition of any one of claims 1 to ~~5~~12, 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.

~~14.~~7. The composition of any one of claims 1 to ~~6~~13, 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 about 1.

~~15. The composition of any one of claims 1 to 14, wherein the composition has a ratio of karanjin to pongamol of greater than about 1.~~

~~16.~~8. The composition of any one of claims 1 to ~~13~~7, 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 about 200 ppm karanjin and pongamol combined.

~~17. The composition of any one of claims 1 to 13 and 16, 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 about 200 ppm karanjin and pongamol combined.~~

~~18.~~9. The composition of any one of claims 1 to ~~6~~13, ~~16 and 17~~, 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.

~~19. The composition of any one of claims 1 to 13 and 16 to18, wherein the composition has a ratio of karanjin to pongamol of less than or equal to 1.~~

~~20.~~10. The composition of any one of claims 1 to ~~19~~9, wherein the composition has:

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

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

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

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

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

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

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

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

(ix) at least about 90% triglycerides,

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

~~21. The composition of any one of claims 1 to 20, wherein the karanjin and pongamol concentration is determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition.~~

~~22.~~11. An analytical method, comprising:

combining pongamia oil with an extraction solvent to provide an extraction mixture, wherein the extraction solvent comprises alkyl ketone, optionally wherein the alkyl ketone is acetone, and wherein the pongamia oil comprises karanjin or pongamol, or both;

sonicating the extraction mixture to produce a sonicated mixture;

separating the sonicated mixture into an extracted pongamia composition and an alkyl ketone extract, wherein the extract comprises karanjin or pongamol, or both; and

measuring the concentration of karanjin or pongamol, or both, present in the extract, optionally wherein the measuring step comprises determining the concentration of karanjin or pongamol, or both, by high performance liquid chromatography with an ultraviolet detector, optionally wherein the ultraviolet detector is a diode array detector.

~~23. The method of claim 22, wherein the alkyl ketone is acetone.~~

~~24. The method of claim 22 or 23, wherein the measuring step comprises determining the concentration of karanjin or pongamol, or both, by high performance liquid chromatography with an ultraviolet detector.~~

~~25. The method of claim 24, wherein the ultraviolet detector is a diode array detector.~~

~~26.~~12. A method for producing a pongamia oil composition, comprising:

combining crude pongamia oil with non-polar solvent to produce a crude mixture, wherein the non-polar solvent comprises alkane, optionally wherein the non-polar solvent comprises hexane, and wherein the crude pongamia oil comprises pongamia oil and furanoflavonoids, optionally wherein the crude pongamia oil is mechanically separated pongamia oil , and optionally wherein the crude pongamia oil is combined with the non-polar solvent in a ratio between 1:1 and 3:1 (w/v);~~;~~

eluting the crude mixture through silica gel with the non-polar solvent to separate at least a portion of the furanoflavonoids from the pongamia oil, and to produce a purified mixture comprising pongamia oil and the non-polar solvent; and

removing at least a portion of the non-polar solvent from the purified mixture to produce a pongamia oil composition, wherein the composition has less than or equal to about 1000 ppm of karanjin and pongamol combined as determined by HPLC-DAD analysis of an acetone extract obtained from the pongamia oil composition; optionally wherein the concentration of karanjin or pongamol, or both, is determined by the method of claim 11, less than or equal to about 1% by weight of unsaponifiable matter; a peroxide value of less than or equal to about 5 meq/kg; and a p-anisidine value of less than or equal to about 10.

~~27.~~13. The method of claim 12~~26~~, 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.

~~28. The method of claim 27, 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.~~

~~29. The method of any one of claims 26 to 28, wherein the crude pongamia oil is mechanically separated pongamia oil.~~

~~30.~~14. The method of ~~any one of claims 26 to 29~~claim 12 or claim 13, further comprising:

dehulling pongamia oilseeds to produce dehulled oilseeds; and

mechanically separating the dehulled oilseeds to produce the crude pongamia oil and a seedcake that is at least partially deoiled; or

heating pongamia oilseeds at a temperature between 25°C and 200°C for a suitable time to provide treated oilseeds;

dehulling the treated oilseeds to produce dehulled oilseeds; and

mechanically separating the dehulled oilseeds to produce the crude pongamia oil and a seedcake that is at least partially deoiled.

~~31. The method of any one of claims 26 to 30, further comprising:~~

~~heating pongamia oilseeds at a temperature between 25°C and 200°C for a suitable time to provide treated oilseeds;~~

~~dehulling the treated oilseeds to produce dehulled oilseeds; and~~

~~mechanically separating the dehulled oilseeds to produce the crude pongamia oil and a seedcake that is at least partially deoiled.~~

~~32. The method of any one of claims 26 to 31, wherein the non-polar solvent comprises hexane.~~

~~33. The method of any one of claims 26 to 32, wherein the concentration of karanjin or pongamol, or both, is determined by the method of any one of claims 21 to 24.~~

~~34. The method of any one of claims 26 to 33, wherein the crude pongamia oil is combined with the non-polar solvent in a ratio between 1:1 and 3:1 (w/v).~~

~~35.~~15. The method of any one of claims ~~26~~ 12 to ~~34~~14, wherein the karanjin and pongamol are adsorbed on the silica gel, and the method further comprises:

eluting the silica gel with a polar solvent to isolate the karanjin and pongamol, wherein the polar solvent comprises alkyl alkanoate, optionally wherein the polar solvent comprises ethyl acetate; or

eluting the silica gel using a stepwise gradient with increasing proportions of polar solvent in the non-polar solvent to isolate karanjin and pongamol separately, wherein the polar solvent comprises alkyl alkanoate, optionally wherein the polar solvent comprises ethyl acetate.

~~36. The method of any one of claims 26 to 35, wherein the karanjin and pongamol are adsorbed on the silica gel, and the method further comprises:~~

~~eluting the silica gel using a stepwise gradient with increasing proportions of polar solvent in the non-polar solvent to isolate karanjin and pongamol separately, wherein the polar solvent comprises alkyl alkanoate.~~

~~37. The method of claim 35 or 36, wherein the polar solvent comprises ethyl acetate.~~

~~38.~~16. A pongamia oil composition produced according to the method of any one of ~~the~~ claims 12~~26~~ to 15~~37~~.

~~39.~~17. Use of the pongamia oil composition of any one of claims 1 to 10~~21~~ and 16~~38~~ 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.

~~40.~~18. A food or beverage product, comprising the pongamia oil composition of any one of claims 1 to 10 and 16~~21 and 38~~, 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.

~~41.~~19. The product of claim 18~~40~~, wherein the composition is light yellow as determined by the Lovibond Color - AOCS Scale; the composition comprises less than or equal to about 200 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

wherein the pongamia oil composition is yellow as determined by the Lovibond Color - AOCS Scale; the composition comprises less than or equal to about 150 ppm karanjin and less than or equal to about 150 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.

~~42. The product of claim 40, wherein the pongamia oil composition is yellow as determined by the Lovibond Color - AOCS Scale; the composition comprises less than or equal to about 150 ppm karanjin and less than or equal to about 150 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.~~

~~43. The product of any one of claims 40 to 42, 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.~~