Claims

1. A method of extracting natural bioactive compounds with differing polarities from a solid plant waste, the method comprising the steps of:

(a) providing a dried or a wet solid plant waste; and

(b) contacting the dried solid plant waste for suitable a period of time and at a suitable temperature with a ternary solvent mixture comprising:

a natural deep eutectic solvent (NADES) comprising glycerol and a further component selected from one or more of the group consisting of an amino acid, a sugar alcohol, a sugar, and urea;

water; and

ethyl acetate, or

contacting the wet solid plant waste for suitable a period of time and at a suitable temperature with a binary solvent mixture comprising:

a natural deep eutectic solvent (NADES) comprising glycerol and a further component selected from one or more of the group consisting of an amino acid, a sugar alcohol, a sugar, and urea; and

ethyl acetate, wherein:

the NADES is a hydrophilic NADES; and

water is present in an amount of from 20 to 40 wt%, relative to:

the total weight of the water and the NADES in the ternary solvent; or

the total weight of water in the wet solid plant waste and the NADES in the binary solvent.

2. The method according to Claim 3, wherein the NADES comprises glycerol and a further component is selected from one or more of the group consisting of betaine, sorbitol, xylitol, glucose, fructose, and urea.

3. The method according to Claim 2, wherein the NADES is formed from:

(ai) glycerol and betaine;

(aii) glycerol and sorbitol;

(aiii) glycerol and glucose;

(aiv) glycerol and fructose; or

(av) glycerol and urea.

4. The method according to Claim 3, wherein the NADES is formed from:

(ai) glycerol and betaine; or

(aiv) glycerol and fructose.

5. The method according to any one of Claims 1 to 4, wherein the molar ratio of glycerol to the further component is from 1:1 to 5:1, such as from 2:1 to 3:1, such as about 3:1.

6. The method according to any one of the preceding claims, wherein water is present in an amount of from 25 to 35 wt%, such as about 30 wt% relative to the total weight of the water and NADES in the ternary solvent.

7. The method according to any one of the preceding claims, wherein the volume to volume ratio of ethyl acetate to water and the NADES in the ternary solvent is from 1:5 to 5:1, such as 1:3 to 3:1, such as about 1:1.

8. The method according to any one of the preceding claims, wherein a solid to liquid ratio (g/mL) of the dried solid plant waste to the ternary solvent is from 1:10 to 1:40, such as from 1:15 to 1:35, such as from 1:18 to 1:35, such as about 1:20.

9. The method according to any one of the preceding claims, wherein one or both of the following apply:
(bi) the suitable amount of time is from 10 minutes to 5 hours, such as from 15 minutes to 2 hours, such as from 20 minutes to 1 hour, such as about 30 minutes; and
(bii) the suitable temperature is from 15 to 65 ºC, such as from 20 to 45 ºC, such as about 25 ºC.

10. The method according to any one of the preceding claims, wherein the solid plant waste is provided in a particulate form, optionally wherein the particles have an average diameter of from 0.1 to 10 mm, such as an average diameter of from 0.5 to 5 mm, such as an average diameter of about 2 mm.

11. The method according to any one of the preceding claims, wherein the dried solid plant waste is provided in a form where substantially all water has been removed, optionally wherein the dried solid plant waste is provided in a freeze-dried form.

12. The method according to any one of the preceding claims, wherein the plant waste is a vegetable waste, optionally wherein the vegetable waste is a cruciferous vegetable waste, further optionally wherein the cruciferous vegetable waste is selected from one or more of

spinach, broccoli, cauliflower and, more particularly, curly kale leaves (*Brassica oleracea var. acephala*).

13. The method according to any one of the preceding claims, wherein the method further comprises separating and retaining a resulting ethyl acetate extract and a resulting NADES/water extract from the solid plant waste following step (b).

14. A solid plant waste extract comprising:

a natural deep eutectic solvent (NADES) comprising glycerol and a further component selected from one or more of the group consisting of betaine, sorbitol, xylitol, glucose, fructose, and urea;

water; and

one or more polyphenol compounds.

15. A ternary solvent comprising:

a natural deep eutectic solvent (NADES) comprising glycerol and a further component selected from one or more of the group consisting of an amino acid, a sugar alcohol, a sugar, and urea;

water; and

ethyl acetate, wherein:

the NADES is a hydrophilic NADES; and

water is present in an amount of from 20 to 40 wt%, relative to the total weight of the water and NADES in the ternary solvent.

16. The ternary solvent according to Claim 15, wherein the NADES comprises glycerol and a further component is selected from one or more of the group consisting of betaine, sorbitol, xylitol, glucose, fructose, and urea.

17. The ternary solvent according to Claim 16, wherein the NADES is formed from:

(ai) glycerol and betaine;

(aii) glycerol and sorbitol;

(aiii) glycerol and glucose;

(aiv) glycerol and fructose; or

(av) glycerol and urea.

18. The ternary solvent according to Claim 17, wherein the NADES is formed from:

(ai) glycerol and betaine; or

(aiv) glycerol and fructose.

19. The ternary solvent according to any one of Claims 15 to 18, wherein the molar ratio of glycerol to the further component is from 1:1 to 5:1, such as from 2:1 to 3:1, such as about 3:1.

20. The ternary solvent according to any one of Claims 15 to 19, wherein water is present in an amount of from 25 to 35 wt%, such as about 30 wt% relative to the total weight of thewater and NADES in the ternary solvent.

21. The ternary solvent according to any one of Claims 15 to 20, wherein the volume to volume ratio of ethyl acetate to water and the NADES is from 1:5 to 5:1, such as 1:3 to 3:1, such as about 1:1.

22. Use of a ternary solvent as described in any one of Claims 1 to 7 or any one of Claims 15 to 21 in extracting natural bioactive compounds with differing polarities from a solid plant waste.