disperse in gastrointestinal fluids, yielding micro- or nanoemulsions containing the solubilized compound.

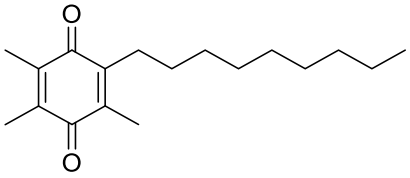
[0005] What are needed are pharmaceutical compositions comprising 2,3,5-trimethyl-6-nonylcyclohexa-2,5-diene-1,4-dione, for example, a SEDDS formulation. Pharmaceutical compositions provided herein show good mitigation of observed positive food effect, good bioavailability, no birefringence when stored, little or no degradation of 2,3,5-trimethyl-6-nonylcyclohexa-2,5-diene-1,4-dione during storage, and/or little or no reduction in potency.

SUMMARY

[0006] There is provided a pharmaceutical composition comprising:

a) about 48 wt/wt% to about 70 wt/wt% of a pharmaceutically acceptable oil, about 12 wt/wt% to about 25 wt/wt% of a propylene glycol laurates composition, and about 8 wt/wt% to about 20 wt/wt% of a polysorbate 80;

b) about 1 wt/wt% to about 15 wt/wt% of **Compound 1:**



and/or the hydroquinone form thereof; wherein **Compound 1**, and/or the hydroquinone thereof is optionally a hydrate thereof, and/or solvate thereof; and wherein when **Compound 1**, and/or hydroquinone thereof, is in the form of a hydrate and/or solvate, then the about 1 wt/wt% to about 15 wt/wt% of **Compound 1**, and/or its hydroquinone, does not include the weight of the water in the hydrate or the weight of the solvent in the solvate; and

c) 0 wt/wt% to about 2% wt/wt% of an optional flavorant;

wherein the wt/wt% of **Compound 1**, the pharmaceutically acceptable oil, the propylene glycol laurates composition, the polysorbate 80, and optional flavorant total 100%.

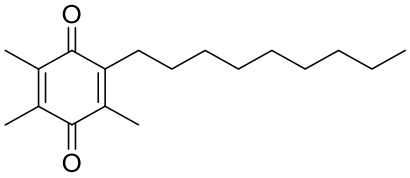
[0006a] In one aspect, provided herein is a pharmaceutical composition comprising:

a) about 48 wt/wt% to about 70 wt/wt% of a pharmaceutically acceptable oil,

b) about 12 wt/wt% to about 25 wt/wt% of a propylene glycol laurates composition,

c) about 8 wt/wt% to about 20 wt/wt% of a polysorbate 80;

d) about 1 wt/wt% to about 15 wt/wt% of **Compound 1:**



and/or the hydroquinone form thereof; or a form thereof, wherein the form thereof is selected from a hydrate and a solvate form; and wherein the wt/wt% of **Compound 1** does not include the weight of the water in the hydrate or the weight of the solvent in the solvate; and

e) 0 wt/wt% to about 2% wt/wt% of an optional flavorant;

wherein the wt/wt% of **Compound 1**, the pharmaceutically acceptable oil, the propylene glycol laurates composition, the polysorbate 80, and optional flavorant total 100%.

[0007] There is also provided a method of preparing a pharmaceutical formulation, comprising:

step a) mixing about 48 wt/wt% to about 70 wt/wt% of the pharmaceutically acceptable oil, about12 wt/wt% to about 25 wt/wt% of the propylene glycol laurates composition, and about 8 wt/wt% to about 20 wt/wt% of the polysorbate 80composition, and 0 wt/wt% to about 2% wt/wt% of an optional flavorant;

step b) adding about 1 wt/wt% to about 15%, of **Compound 1** and/or the hydroquinone form thereof, wherein **Compound 1** and/or the hydroquinone form thereof is optionally a hydrate and/or solvate thereof; to the mixture from step a) and mixing,

and wherein when the **Compound 1**, and/or hydroquinone thereof, is in the form of a hydrate and/or solvate, then the about 1 wt/wt% to about 15 wt/wt% of **Compound 1** and/or its hydroquinone, does not include the weight of any the water in the hydrate or the weight of the solvent in the solvate; and

wherein the wt/wt% of **Compound 1**,,the pharmaceutically acceptable oil, the propylene glycol laurates composition, the polysorbate 80, and optional flavorant total 100%.

[0008] There is also provided methods of using the pharmaceutical composition or pharmaceutical compositions described herein. In some examples, the methods are useful for treating or suppressing a disease or disorder such as an α-synucleinopathy, a tauopathy, an autistic spectrum disorder, a pervasive developmental disorder, a liver disease, liver damage, dementia, and reperfusion injury in a subject using such pharmaceutical compositions.

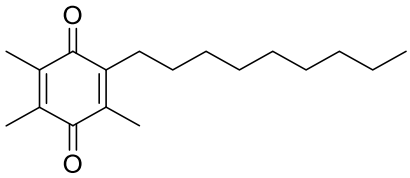
[0008a] In another aspect, provided herein is a pharmaceutical composition as defined herein for use in treating or suppressing a disease or disorder selected from the group consisting of an α-synucleinpathy, a tauopathy, and amyotrophic lateral sclerosis.

[0008b] In another aspect, provided herein is use of a pharmaceutical composition as defined herein in the manufacture of a medicament for treating or suppressing a disease or disorder selected from the group consisting of an α-synucleinpathy, a tauopathy, and amyotrophic lateral sclerosis.

[0009] There is also provided a pharmaceutical composition comprising:

a) about 85 wt/wt% to about 99 wt/wt% of a pharmaceutical acceptable oil;

b) about 1 wt/wt% to about 15% of **Compound 1:**



and/or the hydroquinone form thereof; wherein **Compound 1**, and/or the hydroquinone thereof is optionally a hydrate thereof, and/or solvate thereof; and wherein when **Compound 1**, and/or hydroquinone thereof, is in the form of a hydrate and/or solvate, then the about 1 wt/wt% to

about 15 wt/wt% of **Compound 1**, and/or its hydroquinone, does not include the weight of the water in the hydrate or the weight of the solvent in the solvate; and

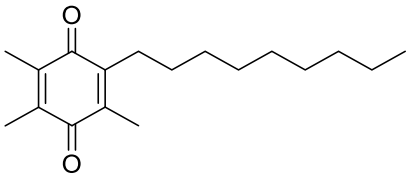
c) 0 wt/wt% to about 2% wt/wt% of an optional flavorant;

wherein the wt/wt% of **Compound 1**, the pharmaceutically acceptable oil, and optional flavorant total 100%.

[0010] There is also provided a pharmaceutical composition comprising:

a) about 48 wt/wt% to about 70 wt/wt% of a pharmaceutically acceptable oil, about 12 wt/wt% to about 25 wt/wt% of a co-surfactant, and about 8 wt/wt% to about 20 wt/wt% of a surfactant;

b) about 1 wt/wt% to about 15 wt/wt% of **Compound 1:**



and/or the hydroquinone form thereof; wherein **Compound 1**, and/or the hydroquinone thereof is optionally a hydrate thereof, and/or solvate thereof; and wherein when **Compound 1**, and/or hydroquinone thereof, is in the form of a hydrate and/or solvate, then the about 1 wt/wt% to about 15 wt/wt% of **Compound 1**, and/or its hydroquinone, does not include the weight of the water in the hydrate or the weight of the solvent in the solvate; and

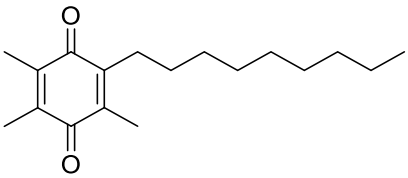
c) 0 wt/wt% to about 2% wt/wt% of an optional flavorant;

wherein the wt/wt% of **Compound 1**, the pharmaceutically acceptable oil, the surfactant, the co-surfactant, and the optional flavorant total 100%.

[0011] There is also provided a pharmaceutical composition comprising:

a) about 65 wt/wt% to about 80 wt/wt% of a Gelucire-like oil, about 8 wt/wt% to about 10 wt/wt% of an excipient like TPGS, and about 8 wt/wt% to about 10 wt/wt% of a polysorbate 80;

b) about 1 wt/wt% to about 17 wt/wt% or about 1 wt/wt% to about 13 wt/wt% or about 1 wt/wt% to about 10 wt/wt% of **Compound 1:**



and/or the hydroquinone form thereof; wherein **Compound 1**, and/or the hydroquinone thereof is optionally a hydrate thereof, and/or solvate thereof; and wherein when **Compound 1**, and/or hydroquinone thereof, is in the form of a hydrate and/or solvate, then the about 1 wt/wt% to about 15 wt/wt% of **Compound 1**, and/or its hydroquinone, does not include the weight of the water in the hydrate or the weight of the solvent in the solvate; and

c) 0 wt/wt% to about 2% wt/wt% of an optional flavorant;

What is claimed is:

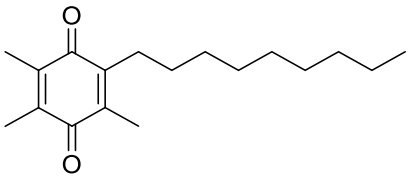
1. A pharmaceutical composition comprising:

a) about 48 wt/wt% to about 70 wt/wt% of a pharmaceutically acceptable oil,

b) about 12 wt/wt% to about 25 wt/wt% of a propylene glycol laurates composition,

c) about 8 wt/wt% to about 20 wt/wt% of a polysorbate 80;

d) about 1 wt/wt% to about 15 wt/wt% of **Compound 1:**



and/or the hydroquinone form thereof; or a form thereof, wherein the form thereof is selected from a hydrate and a solvate form; and wherein the wt/wt% of **Compound 1** does not include the weight of the water in the hydrate or the weight of the solvent in the solvate; and

e) 0 wt/wt% to about 2% wt/wt% of an optional flavorant;

wherein the wt/wt% of **Compound 1**, the pharmaceutically acceptable oil, the propylene glycol laurates composition, the polysorbate 80, and optional flavorant total 100%.

2. The pharmaceutical composition of claim 1, comprising:

a) about 52 wt/wt% to about 65 wt/wt% of a pharmaceutically acceptable oil,

b) about 17 wt/wt% to about 20 wt/wt% of a propylene glycol laurates composition,

c) about 13 wt/wt% to about 20 wt/wt% of a polysorbate 80;

d) about 1 wt/wt% to about 12 wt/wt% of **Compound 1**and/or the hydroquinone form thereof; or a form thereof, wherein the form thereof is selected from a hydrate thereof and a solvate thereof; and wherein the wt/wt% of **Compound 1** does not include the weight of the water in the hydrate or the weight of the solvent in the solvate; and

e) 0 wt/wt% to about 2% wt/wt% of an optional flavorant;

wherein the wt/wt% of **Compound 1**, the pharmaceutically acceptable oil, the propylene glycol laurates composition, the polysorbate 80, and optional flavorant total 100%.

3. The pharmaceutical composition of claim 1 or 2, wherein the ratio of the pharmaceutically acceptable oil to propylene glycol laurates composition to polysorbate 80 is

about 55-75 parts by weight of the pharmaceutically acceptable oil,

about 15-25 parts by weight of the propylene glycol laurates composition,

about 10-20 parts by weight of the polysorbate 80, or

wherein the ratio is 55-75:15-25:10-20 by weight; and

wherein the parts in the ratio of the pharmaceutically acceptable oil to propylene glycol laurates composition to polysorbate 80 total 100.

4. The pharmaceutical composition of any one of claims 1-3, wherein the ratio of the pharmaceutically acceptable oil to propylene glycol laurates composition to polysorbate 80 is

about 60-65 parts by weight of the pharmaceutically acceptable oil,

about 20-25 parts by weight of the propylene glycol laurates composition,

about 15-20 parts by weight of the polysorbate 80, or

wherein the ratio is 60-65:20-25:15-20 by weight; and

wherein the parts in the ratio of the pharmaceutically acceptable oil to propylene glycol laurates composition to polysorbate 80 total 100.

5. The pharmaceutical composition of any one of claims 1-4, wherein the ratio of the pharmaceutically acceptable oil to propylene glycol laurates composition to polysorbate 80 is

about 60 parts by weight of the pharmaceutically acceptable oil,

about 20 parts by weight of the propylene glycol laurates composition,

about 20 parts by weight of the polysorbate 80, or

wherein the ratio is 60:20:20 by weight.

6. The pharmaceutical composition of any one of claims 1-4, wherein the ratio of the pharmaceutically acceptable oil to propylene glycol laurates composition to polysorbate 80 is

about 65 parts by weight of the pharmaceutically acceptable oil,

about 20 parts by weight of the propylene glycol laurates composition,

about 15 parts by weight of the polysorbate 80, or

wherein the ratio is 60:20:15 by weight.

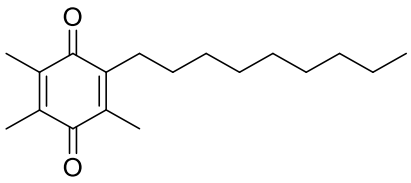
7. The pharmaceutical composition of any one of claims 1-6, wherein the pharmaceutically acceptable oil is selected from the group consisting of one or more of: a Labrafac-like oil (Labrafac WL 1349 or Labrafac PG), sesame oil, cottonseed oil, soybean oil, olive oil, and corn oil.

8. The pharmaceutical composition of any one of claims 1-7, wherein the pharmaceutical composition comprises about 1 wt/wt% to about 12 wt/wt%, about 4 wt/wt% to about 12 wt/wt%, or about 5 wt/wt% to about 10 wt/wt% of **Compound 1**.

9. The pharmaceutical composition of any one of claims 1-8, wherein the pharmaceutical composition contains an amount of **Compound 1** in the composition in the range of about 50 mg to about 120 mg, about 50 mg to about 100 mg, about 60 mg to about 100 mg, about 100 mg to about 120 mg.

10. The pharmaceutical composition of any one of claims 1-9, wherein the pharmaceutical composition is stable when stored at about 5 ºC for a period of at least about 4 weeks.

11. The pharmaceutical composition of any one of claims 1-10, wherein d) is



Compound 1

.

12. The pharmaceutical composition of any one of claims 1-11, wherein the pharmaceutical composition is an oral pharmaceutical composition.

13. The pharmaceutical composition of claims 1-12, wherein the oral pharmaceutical composition is a solution.

14. The pharmaceutical composition of any one of claims 1-13, wherein the pharmaceutical composition comprises a flavorant.

15. The pharmaceutical composition of claims 1-14, wherein the amount of the flavorant is less than 1% wt/wt%.

16. The pharmaceutical composition of claims 14 and 15, wherein the flavorant is selected from the group consisting of a natural flavor, an artificial flavor, a flavor enhancer and mixtures thereof; and optionally, wherein the flavorant is oil soluble.

17. The pharmaceutical composition of any one of claims 14-16, wherein the flavorant comprises a natural or artificial flavor selected from the group consisting of raspberries, punch, cherry, strawberries, and blueberries.

18. A pharmaceutical composition of any one of claims 1-17 for use in treating or suppressing a disease or disorder selected from the group consisting of an α-synucleinpathy, a tauopathy, and amyotrophic lateral sclerosis.

19. Use of a pharmaceutical composition of any one of claims 1-17 in the manufacture of a medicament for treating or suppressing a disease or disorder selected from the group consisting of an α-synucleinpathy, a tauopathy, and amyotrophic lateral sclerosis.

20. The pharmaceutical composition for use of claim 18 or the use of claim 19, wherein the α-synucleinpathy is Parkinson's Disease.

21. The pharmaceutical composition for use of claim 18 or the use of claim 19, wherein the disease or disorder is Amyotrophic Lateral Sclerosis.

22. The pharmaceutical composition for use of any one of claims 18, 20 or 21 or the use of any one of claims 19-21, wherein the pharmaceutical composition is to be administered at a dose selected from 150 mg BID and 250 mg BID.