WHAT IS CLAIMED IS:

1. A process for concentrating at least one omega-3 fatty acid from a fatty acid oil mixture, the process comprising:

(a) combining the fatty acid oil mixture and an aqueous silver salt solution to form an aqueous phase and an organic phase, wherein in the aqueous phase, the aqueous silver salt solution forms a complex with the at least one omega-3 fatty acid;

(b) separating the aqueous phase from the organic phase;

(c) extracting the aqueous phase with a displacement liquid, or increasing the temperature of the aqueous phase to at least 30°C, or a combination of extracting with a displacement liquid and increasing the temperature, resulting in formation of at least one extract;

(d) combining the aqueous phase with water, or extracting the aqueous phase with supercritical CO_2, or a combination of combining the aqueous phase with water and extracting the aqueous phase with supercritical CO_2, to dissociate the complex, wherein an aqueous phase comprising the silver salt and at least one solution comprising a fatty acid concentrate forms; and

(e) separating the at least one solution comprising the fatty acid concentrate from the aqueous phase comprising the silver salt.

2. The process according to claim 1, wherein the concentration of silver salt ranges from about 10% by weight in water to about 90% by weight in water.
3. The process according to claim 2, wherein the concentration of silver salt ranges from about 60% by weight to about 80% by weight in water.
4. The process according to claim 3, wherein the concentration of silver salt is about 60% by weight in water.
5. The process according to claim 1, wherein the silver salt is chosen from $AgNO_3$ and $AgBF_4$.
6. The process according to claim 1, wherein the at least one omega-3 fatty acid is chosen from (all-Z)-5,8,11,14,17-eicosapentaenoic acid (EPA), (all-Z)-4,7,10,13,16,19 docosahexaenoic acid (DHA), and combinations thereof.
7. The process according to claim 6, wherein the process concentrates EPA or DHA, or EPA and DHA.
8. The process according to claim 7, wherein the ratio of EPA/DHA in at least one of the fatty acid concentrate, the at least one extract, and the at least one solution ranges from about 0.1 to about 10 by weight.

9. The process according to claim 1, wherein the fatty acid concentrate comprises at least 90% omega-3 fatty acids by weight.
10. The process according to claim 6, wherein the fatty acid concentrate comprises at least 80% EPA and DHA by weight.
11. The process according to claim 1, wherein the fatty acid concentrate comprises a reduced concentration of at least one omega-6 fatty acid compared to the fatty acid oil mixture.
12. The process according to claim 11, wherein the process increases the ratio of omega-3 to omega-6 fatty acids in the fatty acid concentrate relative to the fatty acid oil mixture.
13. The process according to any of claims 11-12, wherein the ratio of omega-3 fatty acids to omega-6 fatty acids in the fatty acid concentrate is greater than about 40.
14. The process according to any of claims 11-12, wherein the ratio of omega-3 fatty acids to omega-6 fatty acids in the fatty acid concentrate is greater than about 80.
15. The process according to any of claims 11-12, wherein the ratio of omega-3 fatty acids to omega-6 fatty acids in the fatty acid concentrate is greater than about 100.
16. The process according to any of claims 11-12, wherein the ratio of omega-3 fatty acids to omega-6 fatty acids in the fatty acid concentrate is greater than about 150.
17. The process according to any of claims 11-12, wherein the ratio of omega-3 fatty acids to omega-6 fatty acids in the fatty acid concentrate is greater than about 200.
18. The process according to any of claims 11-17, wherein the total concentration of omega-6 fatty acids in the fatty acid concentrate is less than about 3% by weight.
19. The process according to any of claims 11-17, wherein the total concentration of omega-6 fatty acids in the fatty acid concentrate is less than about 2% by weight.
20. The process according to any of claims 11-17, wherein the total concentration of omega-6 fatty acids in the fatty acid concentrate is less than about 1% by weight.
21. The process according to claim 1, wherein the ratio of fatty acid oil mixture to the silver salt solution ranges from about 0.4 to about 1.6 by weight.
22. The process according to claim 1, wherein step (a) further comprises adding an alcohol to the aqueous phase.
23. The process according to claim 22, wherein the alcohol comprises ethanol.
24. The process according to claim 1, wherein the displacement liquid comprises an organic solvent.
25. The process according to claim 24, wherein the organic solvent is chosen from halogenated solvents, alkanes, alkenes, cycloalkanes, and cycloalkenes.

26. The process according to claim 24, wherein the organic solvent is chosen from dichloromethane, hexane, hexene, cyclohexane, cyclohexene, and dienes.
27. The process according to claim 1, wherein extracting the aqueous phase with the displacement liquid comprises at least two successive extractions.
28. The process according to claim 1, wherein the temperature of at least 30°C ranges from about 30°C to about 90°C.
29. The process according to claim 1, wherein combining the aqueous phase with water, or extracting the aqueous phase with supercritical CO_2, or a combination of combining the aqueous phase with water and extracting the aqueous phase with supercritical CO_2, to dissociate the complex is repeated at least once.
30. The process according to claim 1, wherein, following separation of the organic phase comprising the fatty acid concentrate, the silver salt is recovered from the aqueous phase comprising the silver salt for re-use.
31. The process according to claim 1, wherein the fatty acid oil mixture is derived from animal oils, vegetable oils, microbial oils, algae oils, or any combinations thereof.
32. The process according to claim 31, wherein the animal oil is a marine oil.
33. The process according to claim 32, wherein the marine oil is a fish oil.
34. The process according to any of claims 31-33, wherein the oil is in a form chosen from glyceride, ethyl ester, and free fatty acid forms.
35. The process according to claim 1, wherein the fatty acid concentrate comprises a reduced concentration of at least one environmental pollutant compared to the fatty acid oil mixture.
36. The process according to claim 1, wherein the fatty acid concentrate comprises a reduced concentration of cholesterol compared to the fatty acid oil mixture.
37. The process according to claim 1, wherein the at least one omega-3 fatty acid is in a form chosen from ethyl ester, free acid, and glyceride.
38. The process according to claim 1, wherein the fatty acid concentrate comprises a reduced concentration of at least one C_{20}-C_{22} omega-3 fatty acid other than (all-Z)-5,8,11,14,17-eicosapentaenoic acid (EPA) and (all-Z)-4,7,10,13,16,19 docosahexaenoic acid (DHA) compared to the fatty acid oil mixture.
39. The process according to claim 38, wherein the total concentration of C_{20}-C_{22} omega-3 fatty acids other than EPA and DHA in the fatty acid concentrate is less than 3% by weight.

40. The process according to claim 38, wherein the total concentration of C_{20}-C_{22} omega-3 fatty acids other than EPA and DHA in the fatty acid concentrate is less than 2.5% by weight.
41. The process according to claim 38, wherein the total concentration of C_{20}-C_{22} omega-3 fatty acids other than EPA and DHA in the fatty acid concentrate is less than 0.5% by weight.
42. The process according to claim 1, further comprising: (f) purifying the fatty acid concentrate through at least one purification process.
43. The process according to claim 42, wherein the at least one purification process is chosen from short-path distillation, molecular distillation, separation by iodolactonization, supercritical fluid extraction, enzymatic fractionation, and preparative chromatography.
44. The process according to claim 43, wherein the at least one purification process comprises short-path distillation and molecular distillation.
45. The process according to claim 1, wherein the process is repeated at least once wherein at least one of the fatty acid concentrate, the at least one extract, and the at least one solution comprises the fatty acid oil mixture in the subsequent process.
46. The process according to claim 45, wherein the process produces a fatty acid concentrate comprising at least 80% of at least one omega-3 fatty acid chosen from (all-Z)-5,8,11,14,17-eicosapentaenoic acid (EPA), (all-Z)-4,7,10,13,16,19 docosahexaenoic acid (DHA), and (all-Z)-7,10,13,16,19-docosapentaenoic acid (DPA).
47. The process according to claim 45, wherein the process produces a fatty acid concentrate comprising at least 90% of at least one omega-3 fatty acid chosen from EPA, DHA, and DPA.
48. The process according to claim 45, wherein the process produces a fatty acid concentrate comprising at least 95% of at least one omega-3 fatty acid chosen from EPA, DHA, and DPA.
49. The process according to claim 45, wherein the process produces a fatty acid concentrate comprising at least 98% of at least one omega-3 fatty acid chosen from EPA, DHA, and DPA.
50. The process according to claim 1, wherein at least one of the fatty acid concentrate, the at least one extract. and the at least one solution is treated by at least one fractionation process.
51. The process according to claim 50, wherein the at least one fractionation process is chosen from distillation, extraction, iodolactonization, and chromatography.

52. The process according to any of claims 50-51, wherein the at least one fractionation process produces a fatty acid concentrate comprising at least 80% of at least one omega-3 fatty acid chosen from C_{20}-C_{22} omega-3 fatty acids.
53. The process according to any of claims 50-51, wherein the at least one fractionation process produces a fatty acid concentrate comprising at least 90% of at least one omega-3 fatty acid chosen from C_{20}-C_{22} omega-3 fatty acids.
54. The process according to any of claims 50-51, wherein the at least one fractionation process produces a fatty acid concentrate comprising at least 95% of at least one omega-3 fatty acid chosen from C_{20}-C_{22} omega-3 fatty acids.
55. The process according to any of claims 50-51, wherein the at least one fractionation process produces a fatty acid concentrate comprising at least 98% of at least one omega-3 fatty acid chosen from C_{20}-C_{22} omega-3 fatty acids.
56. The process according to any of claims 50-51, wherein the at least one omega-3 fatty acid is chosen from (all-Z)-4,7,10,13,16,19-docosahexaenoic acid (DHA) and (all-Z)-7,10,13,16,19-docosapentaenoic acid (DPA).
57. The process according to claim 1, wherein the fatty acid oil mixture comprises at least one persistent organic pollutant chosen from dioxines, PCBs, DDT, and PDBE.
58. The process according to claim 57, wherein the process reduces the at least one persistent organic pollutant in the fatty acid oil mixture by at least 95% in the fatty acid concentrate.
59. The process according to claim 1, wherein the fatty acid oil mixture comprises cholesterol.
60. The process according to claim 59, wherein the process reduces cholesterol in the fatty acid oil mixture to less than 0.1 mg/g in the fatty acid concentrate.
61. The process according to claim 1, wherein the supercritical CO_2 comprises at least one polar modifier.
62. The process according to claim 61, wherein the at least one polar modifier is chosen from water and an alcohol.
63. The process according to claim 1, wherein the fatty acid oil mixture and the aqueous silver salt solution are combined at a temperature ranging from about -25°C to about 20°C, from about 20°C to about 25°C, or from about 25°C to about 90°C.
64. The process according to claim 1, wherein, following combining the fatty acid oil mixture and the aqueous silver salt solution, the aqueous phase is separated from the organic phase at a temperature ranging from about -25°C to about 20°C, from about 20°C to about 25°C, or from about 25°C to about 90°C.

CLAIMS

1. A process for concentrating at least one omega-3 fatty acid from a fatty acid oil mixture, while reducing the concentration of at least one omega-6 fatty acid in the fatty acid oil mixture, the process comprising:

(a) combining the fatty acid oil mixture and an aqueous silver salt solution to form an aqueous phase and an organic phase, wherein in the aqueous phase, the aqueous silver salt solution forms a complex with the at least one omega-3 fatty acid;

(b) separating the aqueous phase from the organic phase;

(c) extracting the aqueous phase with a displacement liquid, or increasing the temperature of the aqueous phase to at least 30°C, or a combination of extracting with a displacement liquid and increasing the temperature, resulting in formation of at least one extract;

(d) combining the aqueous phase with water, or extracting the aqueous phase with supercritical CO_2, or a combination of combining the aqueous phase with water and extracting the aqueous phase with supercritical CO_2, to dissociate the complex, wherein an aqueous phase comprising the silver salt and at least one solution comprising a fatty acid concentrate forms; and

(e) separating the at least one solution comprising the fatty acid concentrate from the aqueous phase comprising the silver salt,

wherein the ratio of omega-3 to omega-6 fatty acids in the fatty acid concentrate is greater than about 40, greater than about 80, greater than about 100, greater than about 150, or greater than about 200.

2. The process according to claim 1, wherein the concentration of silver salt ranges from about 10% by weight in water to about 90% by weight in water.

3. The process according to claim 2, wherein the concentration of silver salt ranges from about 60% by weight to about 80% by weight in water.

4. The process according to claim 3, wherein the concentration of silver salt is about 60% by weight in water.

5. The process according to claim 1, wherein the silver salt is chosen from $AgNO_3$ and $AgBF_4$.

6. The process according to claim 1, wherein the at least one omega-3 fatty acid is chosen from (all-Z)-5,8,11,14,17-eicosapentaenoic acid (EPA), (all-Z)-4,7,10,13,16,19 docosahexaenoic acid (DHA), and combinations thereof.

7. The process according to claim 6, wherein the process concentrates EPA or DHA, or EPA and DHA.

8. The process according to claim 7, wherein the ratio of EPA/DHA in at least one of the fatty acid concentrate, the at least one extract, and the at least one solution ranges from about 0.1 to about 10 by weight.

9. The process according to claim 1, wherein the fatty acid concentrate comprises at least 90% omega-3 fatty acids by weight.

10. The process according to claim 6, wherein the fatty acid concentrate comprises at least 80% EPA and DHA by weight.

11. The process according to claim 1, wherein the total concentration of omega-6 fatty acids in the fatty acid concentrate is less than about 3% by weight.

12. The process according to claim 1, wherein the total concentration of omega-6 fatty acids in the fatty acid concentrate is less than about 2% by weight.

13. The process according to claim 1, wherein the total concentration of omega-6 fatty acids in the fatty acid concentrate is less than about 1% by weight.

14. The process according to claim 1, wherein the ratio of fatty acid oil mixture to the silver salt solution ranges from about 0.4 to about 1.6 by weight.

15. The process according to claim 1, wherein step (a) further comprises adding an alcohol to the aqueous phase.

16. The process according to claim 15, wherein the alcohol comprises ethanol.

17. The process according to claim 1, wherein the displacement liquid comprises an organic solvent.

18. The process according to claim 17, wherein the organic solvent is chosen from halogenated solvents, alkanes, alkenes, cycloalkanes, and cycloalkenes.

19. The process according to claim 17, wherein the organic solvent is chosen from dichloromethane, hexane, hexene, cyclohexane, cyclohexene, and dienes.

20. The process according to claim 1, wherein extracting the aqueous phase with the displacement liquid comprises at least two successive extractions.

21. The process according to claim 1, wherein the temperature of at least 30°C ranges from about 30°C to about 90°C.

22. The process according to claim 1, wherein combining the aqueous phase with water, or extracting the aqueous phase with supercritical CO_2, or a combination of combining the aqueous phase with water and extracting the aqueous phase with supercritical CO_2, to dissociate the complex is repeated at least once.

23. The process according to claim 1, wherein, following separation of the organic phase comprising the fatty acid concentrate, the silver salt is recovered from the aqueous phase comprising the silver salt for re-use.

24. The process according to claim 1, wherein the fatty acid oil mixture is derived from animal oils, vegetable oils, microbial oils, algae oils, or any combinations thereof.

25. The process according to claim 24, wherein the animal oil is a marine oil.

26. The process according to claim 25, wherein the marine oil is a fish oil.

27. The process according to any of claims 24-26, wherein the oil is in a form chosen from glyceride, ethyl ester, and free fatty acid forms.

28. The process according to claim 1, wherein the fatty acid concentrate comprises a reduced concentration of at least one environmental pollutant compared to the fatty acid oil mixture.

29. The process according to claim 1, wherein the fatty acid concentrate comprises a reduced concentration of cholesterol compared to the fatty acid oil mixture.

30. The process according to claim 1, wherein the at least one omega-3 fatty acid is in a form chosen from ethyl ester, free acid, and glyceride.

31. The process according to claim 1, wherein the fatty acid concentrate comprises a reduced concentration of at least one C_{20}-C_{22} omega-3 fatty acid other than (all-Z)-5,8,11,14,17-eicosapentaenoic acid (EPA) and (all-Z)-4,7,10,13,16,19 docosahexaenoic acid (DHA) compared to the fatty acid oil mixture.

32. The process according to claim 31, wherein the total concentration of C_{20}-C_{22} omega-3 fatty acids other than EPA and DHA in the fatty acid concentrate is less than 3% by weight.

33. The process according to claim 31, wherein the total concentration of C_{20}-C_{22} omega-3 fatty acids other than EPA and DHA in the fatty acid concentrate is less than 2.5% by weight.

34. The process according to claim 31, wherein the total concentration of C_{20}-C_{22} omega-3 fatty acids other than EPA and DHA in the fatty acid concentrate is less than 0.5% by weight.

35. The process according to claim 1, further comprising: (f) purifying the fatty acid concentrate through at least one purification process.

36. The process according to claim 35, wherein the at least one purification process is chosen from short-path distillation, molecular distillation, separation by iodolactonization, supercritical fluid extraction, enzymatic fractionation, and preparative chromatography.

37. The process according to claim 36, wherein the at least one purification process comprises short-path distillation and molecular distillation.

38. The process according to claim 1, wherein the process is repeated at least once wherein at least one of the fatty acid concentrate, the at least one extract, and the at least one solution comprises the fatty acid oil mixture in the subsequent process.

39. The process according to claim 38, wherein the process produces a fatty acid concentrate comprising at least 80% of at least one omega-3 fatty acid chosen from (all-Z)-5,8,11,14,17-eicosapentaenoic acid (EPA), (all-Z)-4,7,10,13,16,19 docosahexaenoic acid (DHA), and (all-Z)-7,10,13,16,19-docosapentaenoic acid (DPA).

40. The process according to claim 38, wherein the process produces a fatty acid concentrate comprising at least 90% of at least one omega-3 fatty acid chosen from EPA, DHA, and DPA.

41. The process according to claim 38, wherein the process produces a fatty acid concentrate comprising at least 95% of at least one omega-3 fatty acid chosen from EPA, DHA, and DPA.

42. The process according to claim 38, wherein the process produces a fatty acid concentrate comprising at least 98% of at least one omega-3 fatty acid chosen from EPA, DHA, and DPA.

43. The process according to claim 1, wherein at least one of the fatty acid concentrate, the at least one extract. and the at least one solution is treated by at least one fractionation process.

44. The process according to claim 43, wherein the at least one fractionation process is chosen from distillation, extraction, iodolactonization, and chromatography.

45. The process according to any one of claims 43-44, wherein the at least one fractionation process produces a fatty acid concentrate comprising at least 80% of at least one omega-3 fatty acid chosen from C_{20}-C_{22} omega-3 fatty acids.

46. The process according to any one of claims 43-44, wherein the at least one fractionation process produces a fatty acid concentrate comprising at least 90% of at least one omega-3 fatty acid chosen from C_{20}-C_{22} omega-3 fatty acids.

47. The process according to any one of claims 43-44, wherein the at least one fractionation process produces a fatty acid concentrate comprising at least 95% of at least one omega-3 fatty acid chosen from C_{20}-C_{22} omega-3 fatty acids.

48. The process according to any one of claims 43-44, wherein the at least one fractionation process produces a fatty acid concentrate comprising at least 98% of at least one omega-3 fatty acid chosen from C_{20}-C_{22} omega-3 fatty acids.

49. The process according to any one of claims 43-44, wherein the at least one omega-3 fatty acid is chosen from (all-Z)-4,7,10,13,16,19-docosahexaenoic acid (DHA) and (all-Z)-7,10,13,16,19-docosapentaenoic acid (DPA).

50. The process according to claim 1, wherein the fatty acid oil mixture comprises at least one persistent organic pollutant chosen from dioxines, PCBs, DDT, and PDBE.

51. The process according to claim 50, wherein the process reduces the at least one persistent organic pollutant in the fatty acid oil mixture by at least 95% in the fatty acid concentrate.

52. The process according to claim 1, wherein the fatty acid oil mixture comprises cholesterol.

53. The process according to claim 52, wherein the process reduces cholesterol in the fatty acid oil mixture to less than 0.1 mg/g in the fatty acid concentrate.

54. The process according to claim 1, wherein the supercritical CO_2 comprises at least one polar modifier.

55. The process according to claim 54, wherein the at least one polar modifier is chosen from water and an alcohol.

56. The process according to claim 1, wherein the fatty acid oil mixture and the aqueous silver salt solution are combined at a temperature ranging from about -25°C to about 20°C, from about 20°C to about 25°C, or from about 25°C to about 90°C.

57. The process according to claim 1, wherein, following combining the fatty acid oil mixture and the aqueous silver salt solution, the aqueous phase is separated from the organic phase at a temperature ranging from about -25°C to about 20°C, from about 20°C to about 25°C, or from about 25°C to about 90°C.