addition, elongase enzymes aslo extend acyl chain length in 2 carbon increments. KCS enzymes condense acyl-CoA molecules with two carbons from malonyl-CoA to form beta-ketoacyl-CoA. KCS and elongases may show specificity for condensing acyl substrates of particular carbon length, modification (such as hydroxylation), or degree of saturation. For example, the jojoba (*Simmondsia chinensis*) beta-ketoacyl-CoA synthase has been demonstrated to prefer monounsaturated and saturated C18- and C20-CoA substrates to elevate production of erucic acid in transgenic plants (Lassner et al., *Plant Cell*, 1996, Vol 8(2), pp 281-292), whereas specific elongase enzymes of *Trypanosoma brucei* show preference for elongating short and midchain saturated CoA substrates (Lee et al., *Cell*, 2006, Vol 126(4), pp 691-9).

[0007] The type II fatty acid biosynthetic pathway employs a series of reactions catalyzed by soluble proteins with intermediates shuttled between enzymes as thioesters of acyl carrier protein (ACP). By contrast, the type I fatty acid biosynthetic pathway uses a single, large multifunctional polypeptide.

[0008] The oleaginous, non-photosynthetic alga, *Protetheca moriformis*, stores copious amounts of triacylglyceride oil under conditions when the nutritional carbon supply is in excess, but cell division is inhibited due to limitation of other essential nutrients. Bulk biosynthesis of fatty acids with carbon chain lengths up to C18 occurs in the plastids; fatty acids are then exported to the endoplasmic reticulum where (if it occurs) elongation past C18 and incorporation into triacylglycerides (TAGs) is believed to occur. Lipids are stored in large cytoplasmic organelles called lipid bodies until environmental conditions change to favor growth, whereupon they are mobilized to provide energy and carbon molecules for anabolic metabolism.

SUMMARY OF THE INVENTION

[0009] In one aspect, an oleaginous microalgal cell of the genus *Prototheca*, optionally comprising an exogenous sucrose invertase gene so that the cell can grow on sucrose as a sole carbon source, the cell comprising an exogenous gene encoding an active LPAAT enzyme, the cell producing an oil comprising triglycerides, wherein the oil is, by virtue of the LPAAT activity: (a) enriched in triglycerides with midchain fatty acids; or (b) enriched in triglycerides of the saturated-unsaturated-saturated type. ~~the present invention provides~~Also provided herein is an oleaginous microalgal cell, optionally comprising 23S rRNA having at least 65% nucleotide sequence identity to SEQ ID NO: 76, optionally obligately heterotrophic, and optionally comprising an exogenous sucrose invertase gene so that the cell can grow on sucrose as a sole carbon source, wherein the cell comprises an exogenous gene

encoding an active LPAAT enzyme, and the cell produces an oil comprising triglycerides, wherein the oil is, by virtue of the LPAAT activity: (a) enriched in triglycerides with midchain fatty acids; or (b) enriched in triglycerides of the saturated-unsaturated-saturated type.

[0010] In some cases, the triglycerides of the oil comprise 40, 50, 60, 70, or 80% or more of C8:0, C10:0, C12:0, C14:0, or C16:0 fatty acids. In some cases, the cell further comprises

an exogenous gene encoding an active FATB acyl-ACP thioesterase. In some cases, the triglycerides of the oil are enriched in midchain fatty acids by greater than 70% as a result of the expression of the exogenous LPAAT and acyl-ACP thioesterase. In some cases, the cell further comprises recombinant nucleic acids operable to encode an exogenous KAS I or KAS IV enzyme to reduce the activity of an endogenous KAS I enzyme. In some cases, the cell further comprises nucleic acids operable to reduce the expression of a delta 12 fatty acid desaturase, optionally via a regulatable promoter, so as to produce an oil with linoleic and linolenic acids totaling 5 area percent or less by FAME GC/FID. In some cases, the oil is enriched in triglycerides of the saturated-unsaturated-saturated type. In some cases, the oil is enriched in SOS, POS, and/or POP. In some cases, the oil comprises triglycerides comprising at least 50% SOS, and optionally less than 10% SSS.

[0011] In some cases, the cell further comprises a knockout or knockdown of a stearoyl-ACP desaturase gene, FatA gene, or both. In some cases, the cell further comprises recombinant nucleic acids operable to increase beta-ketoacyl CoA synthase activity. In some cases, the nucleic acids operable to increase beta-ketocyl synthase activity comprise an exogenous gene encoding a beta-ketoacyl CoA synthase.

[0012] In some cases, the ratio of stearate to oleate in oil is 3:1 ± 20%. In some cases, POP, SOS, and POS in the oil comprise at least 30% in sum. In some cases, the oil comprises at least 30% POS. In some cases, the oil comprises POP at 16% ±20%, POS at 38%±20%, and SOS at 23% ± 20%. In some cases, the fatty acid profile of the oil comprises 1 to 4% arachidic acid.

[0013] In some cases, the cell further comprises nucleic acids operable to reduce the expression of a delta 12 fatty acid desaturase, optionally via a regulatable promoter, so as to produce an oil with linoleic and linolenic acids totaling 5 area percent or less. In some cases, the oil has greater than 65% SOS, less than 45% unsaturated fatty acid, less than 5% polyunsaturated fatty acids, less than 1% lauric acid, and less than 2% trans fatty acids.

[0014] In some cases, the LPAAT has the amino acid sequence of SEQ ID NO: 78 or SEQ ID NO: 79 or a sequence having at least 95% identity to SEQ ID NO:78 or SEQ ID NO: 79.

[0015] In another aspect, the present invention provides a method for producing an oil comprising providing or cultivating a cell as discussed above, and extracting the oil. ~~,~~ In one example of the method, ~~wherein~~ the cell is optionally cultivated heterotrophically.

[0016] In another aspect, the present invention provides an oil comprising triglycerides produced by the method discussed above. In some cases, the oil comprises one or more of: at least 10% ergosterol; ergosterol and b-sitosterol, wherein the ratio of ergosterol to b-sitosterol

is greater than 25:1;ergosterol and brassicasterol;ergosterol, brassicasterol, and poriferasterol, and the oil is optionally free from one or more of β-sitosterol, campesterol, and stigmasterol.

[0017] In some cases, the oil forms β polymorph crystals. In some cases, the crystals have a 2L lamellae structure. In some cases, the crystals have a 3L lamellae structure.

[0018] In some cases, the oil forms β' polymorph crystals. In some cases, the crystals have a 2L lamellae structure. In some cases, the crystals have a 3L lamellae structure.

[0019] In some cases, wherein the triglycerides of the oil have a fatty acid profile characterized in that the sum of the percentage of stearate and palmitate is equal to the percentage of oleate multiplied by 2.0 +/- 40%. In some cases, the oil has greater than 65% SOS triglycerides, less than 45% unsaturated fatty acid, less than 5% unsaturated fatty acids, less than 1% lauric acid, and less than 2% trans fatty acid. In some cases, the sum of the percent stearate and palmitate in the fatty acid profile of the oil is twice the percentage of oleate, ± 20%. In some cases, the sn-2 profile of the oil has at least 40% oleate. In some cases, the oil is at least 40, 50, 60, 70, 80, or 90% SOS.

[0020] In some cases, the oil is a roll-in shortening having a melting temperature of between 30°C and 40°C. In some cases, the oil comprises β' polymorphic crystals. In some cases, the oil has a solid fat content of less than 15% at 35°C. In some cases, the oil comprises15 to 20% C8 to C14 fatty acids, 45-50% fatty acids of C16 and higher, and/or 30-25% unsaturated fatty acids.

[0021] In another aspect, the present invention provides a food, fuel or chemical product produced using the oil discussed above.

[0022] In another ~~aspect~~example, the present ~~invention~~ disclosure provides a natural oil or RBD oil produced from a natural oil, in which the oil comprises 3.5% or less saturated fatty acids, and optionally comprises greater than 50% oleic acid and/or greater than 1% palmitoleic acid. In some cases, the oil has between 0.1 and 3.5% saturated fatty acids. In some cases, the oil comprises at least 90% oleic acid. In some cases, the oil comprises at least 3% polyunsaturated fatty acids.

[0023] In another ~~aspect~~example, the present ~~invention~~ disclosure provides an oleaginous cell, optionally comprising 23S rRNA having at least 65% nucleotide sequence identity to SEQ ID NO: 76 and optionally obligately heterotrophic, wherein the cell produces an oil comprising 3.5% or less saturated fatty acids.

[0024] In some cases, the cell is a microalgal cell, optionally of the genus *Prototheca*. In some cases, the cell further comprises a FATA knockout or knockdown. In some cases, the cell comprises an exogenous gene encoding an enzyme active to desaturate palmitoyl-CoA to

plamitoyl-CoA. In some cases, the exogenous gene is a PAD gene. In some cases, the exogenous gene is a SAD gene having desaturase activity toward palmitoyl-ACP. In some cases, the cell further comprises an overexpressed KAS II enzyme.

[0025] In some cases, the cell further comprises nucleic acids operable to reduce the expression of a delta 12 fatty acid desaturase, optionally via a regulatable promoter, so as to produce an oil with linoleic and linolenic acids totaling 5 area percent or less.

[0026] In another ~~aspect~~example, the present ~~invention~~ disclosure provides an oil produced by the cells discussed above, optionally refined, bleached and deodorized, wherein the oil comrpises one or more of: at least 10% ergosterol; ergosterol and b-sitosterol, wherein the ratio of ergosterol to b-sitosterol is greater than 25:1; ergosterol and brassicasterol; and ergosterol, brassicasterol, and poriferasterol, and wherein the oil is optionally free from one or more of β-sitosterol, campesterol, and stigmasterol.

[0027] In another ~~aspect~~example, the present ~~invention~~ disclosure provides a method for producing an oil having 3.5% or less saturated fatty acids, wherein the method comprises providing or cultivating a cell as discussed above or herein, and extracting the oil from the cell.

[0028] In another example~~aspect~~, the present disclosure~~invention~~ provides a method for producing a food, wherein the method comprises incorporating an oil produced by the methods discussed above or herein into the food, wherein the finished food product has 3.5% or less saturated fat.

[0029] In another example~~aspect~~, the present disclosure~~invention~~ provides a recombinant oleaginous cell, optionally comprising 23S rRNA having at least 65% nucleotide sequence identity to SEQ ID NO: 76 and optionally obligately heterotrophic, wherein the cell comprises an exogenous gene encoding an active ketoacyl-CoA synthase enzyme.

[0030] In some cases, the cell produces an oil comprising greater than 20% erucic acid. In some cases, the cell produces an oil comprising greater than 60% erucic acid. In some cases, the cell comprises at least 40% oil. In some cases, the cell is of the genus *Prototheca*, and optionally of the species *Prototheca moriformis*. In some cases, the oil produced by the cell comprises one or more of: at least 10% ergosterol; ergosterol and b-sitosterol, wherein the ratio of ergosterol to b-sitosterol is greater than 25:1; ergosterol and brassicasterol; and ergosterol, brassicasterol, and poriferasterol, wherein the oil is optionally free from one or more of β-sitosterol, campesterol, and stigmasterol.

[0031] In another ~~aspect~~example, the present disclosure~~invention~~ provides a chemical produced from the oil discussed above.

[0032] In another ~~aspect~~example, the present disclosure~~invention~~ provides a method for producing an oil, wherein the method comprises providing or cultivating a cell as discussed above, and extracting an oil from the cell.

[0033] In another ~~aspect~~example, the present disclosure~~invention~~ provides a recombinant oleaginous cell comprising recombinant nucleic acids operable to suppress the activity of a delta 12 fatty acid desaturase gene product so that the cell produces an oil with a triacylglycerol profile having less than 5% linoleic acid. In some cases, the cell produces an oil with a triacylglycerol profile having less than 3% linoleic acid. In some cases, the cell produces an oil with a triacylglycerol profile having less than 2% linoleic acid.

[0034] In some cases, the cell is a linoleic acid auxotroph or activity of the delta 12 fatty acid desaturase can be suppressed via environmental conditions so as to produce the oil. In some cases, the delta 12 fatty acid desaturase is regulatable via environmental conditions due to a regulatable promoter in operable linkage to the delta 12 fatty acid desaturase gene. In some cases, the regulatable promoter is regulatable by change in media pH or nitrogen levels.

[0035] In some cases, the cell further comprises recombinant nucleic acids operable to express an exogenous KAS II, LPAAT, or FATB enzyme. In some cases, the cell further comprises recombinant nucleic acids operable to knockout or knockdown the expression of a stearoyl ACP desaturase enzyme. In some cases, the cell further comprises recombinant nucleic acids operable to knockout or knockdown the expression of an endogenous FatA-encoded acyl-ACP thioesterase.

[0036] In some cases, the oil is stable at 110°C so that the inflection point in conductance is not yet reached by 20 hours under conditions of the AOCS Cd 12b-92 Rancimat test. In some cases, the oil is stable at 110°C so that the inflection point in conductance is not yet reached by 5 days under conditions of the AOCS Cd 12b-92 Rancimat test, when 1050ppm of tocopherol and 500 pm of ascorbyl palmitate are added to the oil.

[0037] In another ~~aspect~~example, the present disclosure~~invention~~ provides a method comprising: (a) providing a recombinant oleaginous cell, optionally comprising 23S rRNA having at least 65% nucleotide sequence identity to SEQ ID NO: 76, optionally obligately heterotrophic, wherein the cell comprises recombinant nucleic acids operable to modify the amount of a fatty acid made by the cell in response to a change in an environmental condition; (b) cultivating the cell under a first environmental condition that is permissive to synthesis of the fatty acid so as to allow for cell division and increase the number of cells; (c) cultivating the cell under a second environmental condition that, due to the recombinant nucleic acids,

reduces the synthesis of the fatty acid and thus the amount of that fatty acid in an oil produced by the cell; and (d) extracting the oil from the cell.

[0038] In some cases, the cell comprises exogenous nucleic acids operable to reduce the activity of a delta 12 fatty acid desaturase so as to reduce the amount of linoleic acid in the oil. In some cases, the linoleic acid is depleted in the oil by at least than 50, 60, 70, 80, or 90%.

[0039] In some cases, the cell is cultivated heterotrophically. In some cases, the cell is a microalgal cell. In some cases, the cell produces at least 40, 50, 60, 70, 80, or 90% oil by dry cell weight.

[0040] In some cases, the first environmental condition is a first pH and the second environmental condition is a second pH of cultivation media.

[0041] In some cases, the oil, when extracted from the cell, is stable at 110°C so that the inflection point in conductance is not yet reached by 20 hours under conditions of the AOCS Cd 12b-92 Rancimat test. In some cases, the oil, when extracted from the cell, is stable at 110°C so that the inflection point in conductance is not yet reached by 5 days under conditions of the AOCS Cd 12b-92 Rancimat test, when 1050ppm of tocopherol and 500 pm of ascorbyl palmitate are added to the oil.

[0042] In some cases, the cell comprises an exogenous gene encoding a KAS II enzyme and optionally a knockout or knockdown of a FatA gene. In some cases, the recombinant nucleic acids operable to modify the amount of a fatty acid made by the cell comprise an inhibitory RNA targeting a FAD gene, the production of the inhibitory RNA being under control of a regulatable promoter.

[0043] In some cases, the oil is characterized by a fatty acid profile with greater than 60% oleic acid and less than 3% polyunsaturates. In some cases, the oil is characterized by a fatty acid profile with greater than 70% oleic acid and less than 2% polyunsaturates. In some cases, the oil is characterized by a fatty acid profile with greater than 80% oleic acid and less than 1% polyunsaturates.

[0044] In another ~~aspect~~example, the present disclosure~~invention~~ provides an oil produced by the method discussed above. In some cases, the oil comprises 0.01 to 2% linoleic acid and (i) 80 to 95% oleic acid or (ii) more than 40% of C8, C10, C12, C14 or C16 fatty acids. In some cases, the oil further comprises one or more of: at least 10% ergosterol; ergosterol and β-sitosterol, wherein the ratio of ergosterol to β-sitosterol is greater than 25:1; ergosterol and brassicasterol; and ergosterol, brassicasterol, and poriferasterol.

[0045] In another ~~aspect~~example, the present disclosure~~invention~~ provies a product produced by the oil discussed above. In some cases, the product is a food, fuel or chemical. In some cases, the product is a frying oil, lubricating oil, cleaning solvent, surfactant, foam or lubricant. In some cases, the product is an oleic acid dimer.

[0046] In another ~~aspect~~example, the present disclosure~~invention~~ provides a construct, vector, chromosome or host cell comprising nucleic acids encoding a protein having at least 90% identity to SEQ ID NOs: 77 to 79. In some cases, the nucleic acids encode a protein having at least 95% identity to SEQ ID NOs: 77 to 79. In some cases, the nucleic acids encode a protein having at least 98% identity to SEQ ID NOs: 77 to 79. In some cases, the nucleic acids have at least 80, 90, 95, 96, 97, 98, or 99% sequence identity to SEQ ID NOs:80-85 or equivalent sequences by virtue of the degeneracy of the genetic code.

[0047] These and other aspects and embodiments of the invention are described and/or exemplified in the accompanying drawings, a brief description of which immediately follows, the detailed description of the invention, and in the examples. Any or all of the features discussed above and throughout the application can be combined in various embodiments of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0048] Figures 1-14 show fatty acid profiles and melting curves of refined, bleached and deodorized oils from genetically engineered *Prototheca moriformis* strains, as discussed in Example 4;

[0049] Figure 15 shows the stability of different oils as a function of antioxidant concentration, as discussed in Example 5;

[0050] Figure 16 shows various properties of natural oils with very low levels of polyunsaturated fatty acids in accordance with an embodiment of the invention; and

[0051] Figure 17 shows a plot of percent solid fat content for various oils as follows: (a) P. moriformis RBD oil without lipid pathway engineering; (b) Brazilian cocoa butter +25% milkfat; (c) three replicates of P. moriformis RBD oil from a strain expressing hairpin nucleic acids that reduce levels of a SAD allele thus reducing oleic acid and increasing stearic acid in the TAG profile; (d) P. moriformis RBD oil from a strain overexpressing an endogenous OTE (oleoyl acyl-ACP thioesterase, see Example 45); (e) Malaysian cocoa butter +25% milkfat; and (f) Malaysian cocoa butter. The cocoa butter and cocoa butter milkfat values are literature values (Bailey's Industrial Oils and Fat Products, 6th ed.).

[0052] Figure 18 shows the results of thermal stability testing performed on methylated oil prepared from high-oleic (HO) and high-stability high-oleic (HSAO) triglyceride oils

WHAT IS CLAIMED IS:

1. An oleaginous microalgal cell of the genus *Prototheca*, ~~optionally comprising 23S rRNA having at least 65% nucleotide sequence identity to SEQ ID NO: 76, optionally obligately heterotrophic, and~~ optionally comprising an exogenous sucrose invertase gene so that the cell can grow on sucrose as a sole carbon source, the cell comprising an exogenous gene encoding an active LPAAT enzyme, the cell producing an oil comprising triglycerides, wherein the oil is, by virtue of the LPAAT activity:

(a) enriched in triglycerides with midchain fatty acids; or

(b) enriched in triglycerides of the saturated-unsaturated-saturated type.

2. The cell of claim 1, wherein the triglycerides of the oil comprise 40, 50, 60, 70, or 80% or more of C8:0, C10:0, C12:0, C14:0, or C16:0 fatty acids.

3. The cell of claim 1 or 2, wherein the cell further comprises an exogenous gene encoding an active FATB acyl-ACP thioesterase.

4. The cell of claim 3, wherein the triglycerides of the oil are enriched in midchain fatty acids by greater than 70% as a result of the expression of the exogenous LPAAT and acyl-ACP thioesterase.

5. The cell of any one of claims 1 to 4, wherein the cell further comprises recombinant nucleic acids operable to encode an exogenous KAS I or KAS IV enzyme or to reduce the activity of an endogenous KAS I enzyme.

6. The cell of any one of claims 1 to 5, wherein the cell further comprises nucleic acids operable to reduce the expression of a delta 12 fatty acid desaturase, optionally via a regulatable promoter, so as to produce an oil with linoleic and linolenic acids totaling 5 area percent or less by FAME GC/FID.

7. The cell of claim 1, wherein the oil is enriched in triglycerides of the saturated-unsaturated-saturated type.

8. The cell of claim 7, wherein the oil is enriched in SOS, POS, and/or POP.

9. The cell of claim 8, wherein the oil comprises triglycerides comprising at least 50% SOS, and optionally less than 10% SSS.

21. The oleaginous microalgal cell of any one of claims 1 to 20, wherein the cell is a *Prototheca moriformis* cell.

~~21~~22. A method for producing an oil comprising providing or cultivating a cell according to any one of claims 1 to ~~20~~21, and extracting the oil~~, the cell optionally being cultivated heterotrophically~~.

~~22~~23. An oil comprising triglycerides produced according to claim ~~21~~22.

~~23~~24. The oil of claim ~~22~~23, comprising one or more of:

at least 10% ergosterol;

ergosterol and β-sitosterol, wherein the ratio of ergosterol to β-sitosterol is greater than 25:1;

ergosterol and brassicasterol;

ergosterol, brassicasterol, and poriferasterol;

and wherein the oil is optionally free from one or more of β-sitosterol, campesterol, and stigmasterol.

~~24~~25. The oil of claim ~~22~~-23 wherein the oil forms β polymorph crystals.

~~25~~26. The oil of claim ~~24~~25, wherein the crystals have a 2L lamellae structure.

~~26~~27. The oil of claim ~~24~~25, wherein the crystals have a 3L lamellae structure.

~~27~~28. The oil of claim ~~22~~23, wherein the oil forms β' polymorph crystals.

~~28~~29. The oil of claim ~~24~~25, wherein the crystals have a 2L lamellae structure.

~~29~~30. The oil of claim ~~24~~25, wherein the crystals have a 3L lamellae structure.

~~30~~31. The oil of any one of claims ~~22~~-23 to ~~29~~30, wherein the triglycerides have a fatty acid profile characterized in that the sum of the percentage of stearate and palmitate is equal to the percentage of oleate multiplied by 2.0 +/- 40%.

~~31~~32. The oil of any one of claims ~~22~~-23 to ~~30~~31, wherein the oil has greater than 65% SOS triglycerides, less than 45% unsaturated fatty acid, less than 5% unsaturated fatty acids, less than 1% lauric acid, and less than 2% trans fatty acid.

~~32~~33. The oil of any one of claims ~~22~~-23 to ~~31~~32, wherein the sum of the percent stearate and palmitate in the fatty acid profile is twice the percentage of oleate, ± 20% .

~~33~~34. The oil of claim ~~32~~33, wherein the sn-2 profile has at least 40% oleate.

~~34~~35. The oil of any one of claims ~~22~~ 23 to ~~33~~34, wherein the oil is at least 40, 50, 60, 70, 80, or 90% SOS.

~~35~~36. The oil of any one of claims ~~22~~ 23 to ~~33~~34, wherein the oil is a roll-in shortening having a melting temperature of between 30°C and 40°C.

~~36~~37. The oil of claim ~~35~~36, comprising β' polymorphic crystals.

~~37~~38. The oil of claim ~~35~~ 36 or ~~36~~37, having a solid fat content of less than 15% at 35°C.

~~38~~39. The oil of any one of claims ~~35~~ 36 to ~~37~~38, comprising 15 to 20% C8 to C14 fatty acids, 45-50% fatty acids of C16 and higher, and/or 30-25% unsaturated fatty acids.

~~39~~40. A food, fuel or chemical product produced using the oil of any one of claims ~~22~~ 23 to ~~38~~39.

~~40. A natural oil or RBD oil produced from a natural oil, the oil comprising 3.5% or less saturated fatty acids, and optionally comprising greater than 50% oleic acid and/or greater than 1% palmitoleic acid.~~

~~41. The oil of claim 40, having between 0.1 and 3.5% saturated fatty acids.~~

~~42. The oil of claim 40 or 41, comprising at least 90% oleic acid.~~

~~43. The oil of claim 42, comprising at least 3% polyunsaturated fatty acids.~~

~~44. An oleaginous cell, optionally comprising 23S rRNA having at least 65% nucleotide sequence identity to SEQ ID NO: 76 and optionally obligately heterotrophic, that produces an oil comprising 3.5% or less saturated fatty acids.~~

~~45. The cell of claim 44, wherein the cell is of the genus *Prototheca*.~~

~~46. The cell of claim 44, further comprising a FATA knockout or knockdown.~~

~~47. The cell of any one of claims 44 to 46, comprising an exogenous gene encoding an enzyme active to desaturate palmitoyl-CoA to plamitoyl-CoA.~~

~~48. The cell of claim 47, wherein the exogenous gene is a PAD gene.~~

49. The cell of claim 47, wherein the exogenous gene is a SAD gene having desaturase activity toward palmitoyl-ACP.

50. The cell of any one of claims 44 to 49, further comprising an overexpressed KASII enzyme.

51. The cell of any one of claims 44 to 50, further comprising nucleic acids operable to reduce the expression of a delta 12 fatty acid desaturase, optionally via a regulatable promoter, so as to produce an oil with linoleic and linolenic acids totaling 5 area percent or less.

52. An oil produced by the cell of any one of claims 44 to 51, optionally refined, bleached and deodorized, the oil comrpising one or more of:

at least 10% ergosterol;

ergosterol and b-sitosterol, wherein the ratio of ergosterol to b-sitosterol is greater than 25:1;

ergosterol and brassicasterol; and

ergosterol, brassicasterol, and poriferasterol;

wherein the oil is optionally free from one or more of -sitosterol, campesterol, and stigmasterol.

53. A method for producing an oil having 3.5% or less saturated fatty acids, the method comprising providing or cultivating a cell of any one of claims 5 to 12, and extracting the oil from the cell.

54. A method for producing a food comprising incorporating an oil produced by the method of claim 53 into the food, wherein the finished food product has 3.5% or less saturated fat.

55. A recombinant oleaginous cell, optionally comprising 23S rRNA having at least 65% nucleotide sequence identity to SEQ ID NO: 76 and optionally obligately heterotrophic, the cell comprising an exogenous gene encoding an active ketoacyl-CoA synthase enzyme.

56. The cell of claim 55, wherein the cell produces an oil comprising greater than 20% erucic acid.

57. A cell according to claim 56, wherein the cell produces an oil comprising greater than 60% erucic acid.

58. The cell of any one of claims 55 to 57, wherein the cell comprises at least 40% oil.

59. The cell of any one of claims 55 to 58, wherein the cell is of the genus *Prototheca*, and optionally of the species *Prototheca moriformis*.

60. An oil produced by the cell of any one of claims 55 to 59, comprising one or more of:

at least 10% ergosterol;

ergosterol and β-sitosterol, wherein the ratio of ergosterol to β-sitosterol is greater than 25:1;

ergosterol and brassicasterol; and

ergosterol, brassicasterol, and poriferasterol;

wherein the oil is optionally free from one or more of β-sitosterol, campesterol, and stigmasterol.

61. A chemical produced from the oil of claim 60.

62. A method for producing an oil comprising providing or cultivating a cell according to any one of claims 55 to 59 and extracting an oil from the cell.

63. A recombinant oleaginous cell comprising recombinant nucleic acids operable to suppress the activity of a delta 12 fatty acid desaturase gene product so that the cell produces an oil with a triacylglycerol profile having less than 5% linoleic acid.

64. The cell of claim 63, wherein the cell produces an oil with a triacylglycerol profile having less than 3% linoleic acid.

65. The cell of claim 64, wherein the cell produces an oil with a triacylglycerol profile having less than 2% linoleic acid.

66. The cell of claim 63, wherein the cell is a linoleic acid auxotroph or activity of the delta 12 fatty acid desaturase can be suppressed via environmental conditions so as to produce the oil.

67. The cell of claim 66, wherein the delta 12 fatty acid desaturase is regulatable via environmental conditions due to a regulatable promoter in operable linkage to the delta 12 fatty acid desaturase gene.

68. The cell of claim 67, wherein the regulatable promoter is regulatable by change in media pH or nitrogen levels.

69. The cell of any one of claims 64 to 68, further comprising recombinant nucleic acids operable to express an exogenous KASII, LPAAT, or FATB enzyme.

70. The cell of any one of claims 64 to 69, further comprising recombinant nucleic acids operable to knockout or knockdown the expression of a stearoyl ACP desaturase enzyme.

71. The cell of any one of claims 64 to 70, further comprising recombinant nucleic acids operable to knockout or knockdown the expression of an endogenous FatA-encoded acyl-ACP thioesterase.

72. The cell of any one of claims 64 to 71, wherein the oil is stable at 110°C so that the inflection point in conductance is not yet reached by 20 hours under conditions of the AOCS Cd 12b-92 Rancimat test.

73. The cell of any one of claims 64 to 71, wherein the oil is stable at 110°C so that the inflection point in conductance is not yet reached by 5 days under conditions of the AOCS Cd 12b-92 Rancimat test, when 1050ppm of tocopherol and 500 pm of ascorbyl palmitate are added to the oil.

74. A method comprising:

(a) providing a recombinant oleaginous cell, optionally comprising 23S rRNA having at least 65% nucleotide sequence identity to SEQ ID NO:76, optionally obligately heterotrophic, the cell comprising recombinant nucleic acids operable to modify the amount of a fatty acid made by the cell in response to a change in an environmental condition;

(b) cultivating the cell under a first environmental condition that is permissive to synthesis of the fatty acid so as to allow for cell division and increase the number of cells;

(c) cultivating the cell under a second environmental condition that, due to the recombinant nucleic acids, reduces the synthesis of the fatty acid and thus the amount of that fatty acid in an oil produced by the cell; and

(d) extracting the oil from the cell.

75. The method of claim 74, wherein the cell comprises exogenous nucleic acids operable to reduce the activity of a delta 12 fatty acid desaturase so as to reduce the amount of linoleic acid in the oil.

76. The method of claim 74 or 75, wherein the linoleic acid is depleted in the oil by at least than 50, 60, 70, 80, or 90%.

77. The method of any one of claims 74 to 76 wherein the cell is cultivated heterotrophically.

78. The method of any one of claims 74 to 77, wherein the cell is a microalgal cell.

79. The method of any one of claims 74 to 78, wherein the cell produces at least 40, 50, 60, 70, 80, or 90% oil by dry cell weight.

80. The method of any one of claims 74 to 79, wherein the first environmental condition is a first pH and the second environmental condition is a second pH of cultivation media.

81. The method of any one of claims 74 to 80, wherein, when extracted from the cell, the oil is stable at 110°C so that the inflection point in conductance is not yet reached by 20 hours under conditions of the AOCS Cd 12b-92 Rancimat test.

82. The method of any one of claims 74 to 81, wherein when extracted from the cell, the oil is stable at 110°C so that the inflection point in conductance is not yet reached by 5 days under conditions of the AOCS Cd 12b-92 Rancimat test, when 1050ppm of tocopherol and 500 pm of ascorbyl palmitate are added to the oil.

83. The method of any one of claims 74 to 82, wherein the cell comprises an exogenous gene encoding a KAS II enzyme and optionally a knockout or knockdown of a FatA gene.

84. The method of any one of claims 74 to 83, wherein the recombinant nucleic acids operable to modify the amount of a fatty acid made by the cell comprise an inhibitory RNA targeting a FAD gene, the production of the inhibitory RNA being under control of a regulatable promoter.

85. The method of claim 83 or 84, wherein the oil is characterized by a fatty acid profile with greater than 60% oleic acid and less than 3% polyunsaturates.

86. The method of claim 85, wherein the oil is characterized by a fatty acid profile with greater than 70% oleic acid and less than 2% polyunsaturates.

87. The method of claim 86, wherein the oil is characterized by a fatty acid profile with greater than 80% oleic acid and less than 1% polyunsaturates.

88. An oil produced by the method of any one of claims 74 to 87.

89. The oil of claim 88 comprising 0.01 to 2% linoleic acid and (i) 80 to 95% oleic acid or (ii) more than 40% of C8, C10, C12, C14 or C16 fatty acids.

90. The oil of claim 88 or 89, further comprising one or more of:

at least 10% ergosterol;

ergosterol and b-sitosterol, wherein the ratio of ergosterol to b-sitosterol is greater than 25:1;

ergosterol and brassicasterol; and

ergosterol, brassicasterol, and poriferasterol.

91. A product produced from the oil of any one of claims 88 to 90.

92. The product of claim 91, wherein the product is a food, fuel or chemical.

93. The product of claim 91, wherein the product is a frying oil, lubricating oil, cleaning solvent, surfactant, foam or lubricant.

94. The product of claim 91, wherein the product is an oleic acid dimer.

95. A construct, vector, chromosome or host cell comprising nucleic acids encoding a protein having at least 90% identity to SEQ ID NOs: 77 to 79.

96. The construct, vector, chromosome or host cell of claim 95, encoding a protein having at least 95% identity to SEQ ID NOs: 77 to 79.

97. The construct, vector, chromosome or host cell of claim 95, encoding a protein having at least 98% identity to SEQ ID NOs: 77 to 79.

98. The construct, vector, chromosome, or host cell of any of claims 95 to 97, comprising nucleic acids having at least 80, 90, 95, 96, 97, 98, or 99% sequence identity to SEQ ID NOs:80-85 or equivalent sequences by virtue of the degeneracy of the genetic code.