hexane. Extraction of these oils for use as a starting material contributes significantly to the cost of traditional biodiesel production.

[0010] Similar to the solvent extraction processes utilized to extract oils from dried plant materials, solvent extraction of oils from microbial biomass is carried out in the presence of an organic solvent. Solvent extraction in this context requires the use of a solvent that is essentially immiscible in water, such as hexane, to produce a solvent phase, in which the oil is soluble, and an aqueous phase, which retains the largely non-lipid portion of the biomass. Unfortunately, in an industrial scale production, the volume of volatile, potentially carcinogenic, and flammable organic solvent that must be used for efficient extraction creates hazardous operating conditions having both environmental and worker safety aspects. Moreover, the solvent extraction process generates a substantial solvent waste stream that requires proper disposal, thereby increasing overall production costs.

[0011] Alternatively, "solventless" extraction processes have been reported; these employ an aqueous solvent comprising no more than about 5% organic solvent for extracting lipids from microorganisms for use as a feedstock in a transesterification process for the production of biodiesel. Briefly, the "solventless" extraction process includes contacting a lysed cell mixture with an aqueous solvent containing no more than about 5% organic solvent (*e.g.*, hexane) to produce a phase separated mixture. The mixture comprises a heavier aqueous layer and a lighter layer comprising emulsified lipids. The extraction process is repeatedly performed on the lighter lipid layer until a non-emulsified lipid layer is obtained. Unfortunately, the repeated isolation and washing of the lipid layer makes the "solventless" process particularly laborious.

[0012] There remains a need for cheaper, more efficient methods for extracting valuable biomolecules derived from lipids produced by microorganisms. The present invention meets this need.

SUMMARY OF THE INVENTION

[0013] In a first aspect, the present invention refers to a method of making a chemically modified lipid, comprising:

(a) providing a microalgal lipid comprising no more than 500 ppm color-generating impurities, wherein the lipid is obtained from microalgae cultured under heterotrophic growth conditions in a bioreactor substantially in the absence of light; and

(b) subjecting the microalgal lipid to a chemical reaction to produce the modified lipid.

wherein the microalgae are selected from strains of *Parachlorella, Prototheca,* or *Chlorella* or strains having at least 85% nucleotide sequence identity in 23S rRNA sequences to a *Parachlorella, Prototheca,* or *Chlorella* strain.

[0013a] Also described herein is~~relates to~~ the discovery that direct chemical modification of lipid-containing microbial biomass can dramatically increase the efficiency and decrease the cost of obtaining valuable materials derived from those lipids. Thus, in a first ~~embodiment~~example, the~~n~~ ~~invention~~disclosure provides a method of chemically modifying lipid-containing microbial biomass including the steps of culturing a population of microbes, harvesting microbial biomass that contains at least 5% lipid by dry cell weight (DCW), and subjecting the biomass to a chemical reaction that covalently modifies at least 1% of the lipid. In some

~~embodiments~~examples, the method further includes separating the covalently modified lipid from other components of the biomass.

[0014] In various ~~embodiments~~examples, the ratio of the covalently modified lipid to the biomass from which it is separated is between 10% lipid and 90% biomass and 90% biomass and 10% lipid by dry weight. In some ~~embodiments~~examples, the step of separating the lipid from other components of the biomass includes a phase separation step in which the covalently modified lipids form a lighter non-aqueous phase and components of the biomass form one or more heavier phases. In some ~~embodiments~~examples, the biomass is subjected to the chemical reaction without a step of prior enrichment that increases the ratio of the lipids to the non-lipid material by more than 50% by weight. In other ~~embodiments~~examples, the biomass is subjected to the chemical reaction with a step of prior enrichment that increases the ratio of the lipids to the dry weight of the microbes. In some ~~embodiments~~examples, the harvested biomass is not subjected to any treatment other than the removal of water and/or lysis of the cells before the chemical reaction. In some ~~embodiments~~examples, the biomass subjected to the chemical reaction contains components other than water in the same relative proportions as the cell culture. In some ~~embodiments~~examples, the lipid content of the biomass is less than 90% of the biomass subjected to the chemical reaction.

[0015] In one ~~embodiment~~example, chemical modification of the lipid-containing microbial biomass comprises transesterifying the biomass to generate a lipophilic phase containing fatty acid alkyl esters and a hydrophilic phase containing cell material and glycerol. In some ~~embodiments~~examples, the method further comprises removing water from the biomass prior to subjecting the biomass to the transesterifying chemical reaction. In other ~~embodiments~~examples, the method further comprises removing water from the biomass after the disrupting of the biomass. In some ~~embodiments~~examples, removing water from the biomass is performed using a method selected from the group consisting of lyophilization, drum drying, and oven drying the biomass.

[0016] In some ~~embodiments~~examples, in which the chemical modification of the lipid-containing microbial biomass comprises transesterifying the biomass, the method further comprises disrupting the biomass prior to transesterifying the biomass. In some ~~embodiments~~examples, water is removed from the biomass prior to the disrupting of the biomass. In some ~~embodiments~~examples, disrupting the biomass comprises heating the biomass to generate a lysate. In other ~~embodiments~~examples, disrupting the biomass comprises contacting the biomass with an acid or base sufficient to generate a lysate. In still other ~~embodiments~~examples, disrupting the biomass comprises

contacting the biomass with one or more enzymes to generate a lysate. In some ~~embodiments~~examples, the biomass is contacted with at least one protease and at least one polysaccharide-degrading enzyme. In some ~~embodiments~~examples, disrupting the biomass comprises mechanically lysing the population of microbes to generate a lysate. In other ~~embodiments~~examples, disrupting the biomass comprises subjecting the biomass to osmotic shock to generate a lysate. In still other ~~embodiments~~examples, disrupting the biomass comprises infecting the population of microbes with a lytic virus to generate a lysate. In other ~~embodiments~~examples, disrupting the biomass comprises inducing the expression of a lytic gene within the population of microbes to promote autolysis and generation of a lysate.

[0017] In some ~~embodiments~~examples of the chemical modification method in which the chemical reaction comprises transesterification, the fatty acid alkyl esters are fatty acid methyl esters or fatty acid ethyl esters. In some ~~embodiments~~examples, transesterifying the biomass comprises contacting the biomass with an alcohol and a base. In some ~~embodiments~~examples, the alcohol is selected from methanol, ethanol, propanol, isopropanol, and mixtures thereof. In some ~~embodiments~~examples, the base is selected from NaOH, KOH, and mixtures thereof. In one ~~embodiment~~example, the alcohol is methanol and the base is NaOH. In some ~~embodiments~~examples, transesterifying the biomass comprises contacting the biomass with an alcohol and a lipase. In some ~~embodiments~~examples, the lipase is expressed from an exogenous lipase gene within the population of microbes. In some ~~embodiments~~examples, expression of the exogenous lipase gene is induced by contacting the biomass with a stimulus to activate an inducible promoter controlling expression of the exogenous lipase gene.

[0018] In various ~~embodiments~~examples, the amount of calcium and magnesium, combined, by weight in the lipophilic phase is no greater than 5 parts per million. In some ~~embodiments~~examples, the amount of phosphorous in the lipophilic phase is no greater than 0.001%, by mass. In some ~~embodiments~~examples, the amount of sulfur in the lipophilic phase is no greater than 15 parts per million. In some ~~embodiments~~examples, the amount of potassium and sodium, combined, by weight in the lipophilic phase is no greater than 5 parts per million. In some ~~embodiments~~examples, the total carotenoid content of the lipophilic phase is no greater than 100 micrograms of carotenoid per gram. In some ~~embodiments~~examples, the total chlorophyll content in the lipophilic phase is no greater than 0.1 mg/kg.

[0019] In some ~~embodiments~~examples, subjecting the biomass to a chemical reaction includes contacting the biomass with an enzyme to catalyze the chemical reaction. In some ~~embodiments~~examples, the enzyme is a lipase. In one ~~embodiment~~example, the method further comprises

separating a lipophilic phase containing the covalently modified lipids from hydrophilic cell material of the biomass.

[0020] In various ~~embodiments~~examples of the present ~~invention~~disclosure, the microbes and the resulting microbial biomass are selected from the group consisting of bacteria, cyanobacteria, eukaryotic microalgae, oleaginous yeast, and fungi. In some ~~embodiments~~examples, the microbes are selected from the group consisting of the eukaryotic microalgae listed in Table 1. In some ~~embodiments~~examples, the microbes are a species of the genus *Chlorella*, and in various ~~embodiments~~examples, the species is selected from the group consisting of *Chlorella fusca, Chlorella protothecoides, Chlorella pyrenoidosa, Chlorella kessleri, Chlorella vulgaris, Chlorella saccharophila, Chlorella sorokiniana* and *Chlorella ellipsoidea*. In one ~~embodiment~~example, the species is *Chlorella protothecoides*. In some ~~embodiments~~examples, the microbes is a species of the genus *Prototheca*, or the species is selected from the group consisting of *Prototheca wickerhamii, Prototheca stagnora, Prototheca portoricensis, Prototheca moriformis,* and *Prototheca zopfii*. In some ~~embodiments~~examples, the microbes are selected from the group consisting of the oleaginous yeast listed in Table 2, and in other ~~embodiments~~examples, the microbes are selected from the group consisting of the fungi listed in Table 3. In some ~~embodiments~~examples, the microbial biomass comprises a mixture of biomass from two distinct strains or species of microbes that have been separately cultured. In one ~~embodiment~~example, at least two of the distinct strains or species of microbes have different glycerolipid profiles. In some ~~embodiments~~examples, the species has a high degree of taxonomic similarity to members of the *Chlorella* or *Prototheca* genera, such as at least 95% nucleotide identity at the 23S rRNA level, as disclosed in the examples.

[0021] In various ~~embodiments~~examples of the present ~~invention~~disclosure, the harvested biomass comprises a lipid content of at least 5%, at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, or at least 90% by DCW. In some ~~embodiments~~examples, at least 20% of the lipid is C18. In some ~~embodiments~~examples, at least 30% of the lipid is C18. In some ~~embodiments~~examples, at least 40% of the lipid is C18. In some ~~embodiments~~examples, at least 50% of the lipid is C18. In some ~~embodiments~~examples, at least 50% of the lipid is C16 or longer chain lengths. In some ~~embodiments~~examples, at least 10% of the lipid is C14 or shorter chain lengths. In some ~~embodiments~~examples, at least 20% of the lipid is C14 or shorter chain lengths.

[0022] In some ~~embodiments~~examples of the present ~~invention~~disclosure, the population of microbes expresses an exogenous sucrose utilization gene. In some ~~embodiments~~examples, the gene is a sucrose invertase. In some ~~embodiments~~examples, the population of microbes expresses an exogenous lipid

pathway enzyme. In some ~~embodiments~~examples, the lipid pathway enzyme comprises an acyl-ACP thioesterase. In some ~~embodiments~~examples, the population of microbes further expresses an exogenous "naturally co-expressed" acyl carrier protein that is co-expressed with the acyl-ACP thioesterase. In some ~~embodiments~~examples, the lipid pathway enzyme has a specificity for acting on a substrate having a specified number of carbon atoms in a chain.

[0023] In some ~~embodiments~~examples, chemical modification of the lipid-containing microbial biomass comprises hydrogenating the biomass to saturate at least a subset of unsaturated bonds in the lipid. In some ~~embodiments~~examples, chemical modification of the lipid-containing microbial biomass comprises interesterifying the biomass to generate a mixture of glycerolipids having a modified arrangement of fatty acid constituents relative to the glycerolipids in the harvested biomass. In some ~~embodiments~~examples, chemical modification of the lipid-containing microbial biomass comprises hydroxylating the biomass to generate hydroxylated lipids. In some ~~embodiments~~examples, at least a portion of the hydroxylated lipids are esterified to generate estolides. In some ~~embodiments~~examples, chemical modification of the lipid-containing microbial biomass comprises hydrolyzing the biomass to generate free fatty acids from the lipid. In some ~~embodiments~~examples, the free fatty acids are subjected to further chemical modification. In one ~~embodiment~~example, chemical modification of the lipid-containing microbial biomass comprises deoxygenation at elevated temperature in the presence of hydrogen and a catalyst, isomerization in the presence of hydrogen and a catalyst, and removal of gases and naphtha compounds.

[0024] In another ~~embodiment~~example, chemical modification of the lipid-containing microbial biomass comprises saponifying the biomass to generate fatty acid salts from the lipid. In one ~~embodiment~~example, the biomass is derived from a microalgae of the genus *Prototheca*. In some ~~embodiments~~examples, saponifying the biomass comprises contacting the biomass with a base sufficient to convert at least a portion of the glycerolipid and/or fatty acid ester components of the lipid to fatty acid salts. In some ~~embodiments~~examples, the base is an alkali metal hydroxide, such as NaOH or KOH. In some ~~embodiments~~examples, the method further comprises contacting the biomass with a salt to precipitate the fatty acid salts from solution. In some ~~embodiments~~examples, the salt comprises a water-soluble alkali metal halide, such as NaCl or KCl.

[0025] In some ~~embodiments~~examples, two distinct strains or species of microbes are separately cultured, and biomass from both cultures is mixed prior to subjecting the biomass to a chemical reaction that modifies at least 1% of the lipid. In some ~~embodiments~~examples, at least two of the distinct strains of microbes have different glycerolipid profiles.

[0026] In one ~~aspect~~example, the present ~~invention~~disclosure is directed to a saponification method for making a soap. In some ~~embodiments~~examples, the method includes culturing a population of microbes, harvesting microbial biomass that contains at least 5% lipid by DCW, including glycerolipids or fatty acid esters, and subjecting the biomass to an alkaline hydrolysis reaction to produce a soap from the chemical conversion of at least a portion of the glycerolipids or fatty acid esters to fatty acid salts. In some ~~embodiments~~examples, the alkaline hydrolysis reaction includes contacting the biomass with a base and optionally heating the biomass. In some ~~embodiments~~examples, the base is an alkali metal hydroxide such as NaOH or KOH. In some ~~embodiments~~examples, less than 100% of the glycerolipids and fatty acid esters in the biomass are converted to fatty acid salts. In some ~~embodiments~~examples, less than 1% of the glycerolipids and fatty acid esters in the biomass are converted to fatty acid salts.

[0027] In some ~~embodiments~~examples of the saponification method, the method further comprises substantially separating the fatty acid salts from other components of the biomass. Some methods of the ~~invention~~disclosure further comprise boiling the separated fatty acid salts in water and re-precipitating the fatty acid salts by introducing a salt into the aqueous solution to produce a purified soap. In some ~~embodiments~~examples, the salt is a water-soluble alkali metal halide, such as NaCl or KCl.

[0028] Some saponification methods of the ~~invention~~disclosure further comprise combining the purified soap or saponified oil composition with one or more additives selected from the group consisting of essential oils, fragrance oils, flavor oils, botanicals, extracts, CO_2 extracts, clays, colorants, titanium dioxide, micas, tinting herbs, glitters, exfoliants, fruit seeds, fibers, grain powders, nut meals, seed meals, oil beads, wax beads, herbs, hydrosols, vitamins, milk powders, preservatives, antioxidants, tocopherols, salts, sugars, vegetable oils, waxes, glycerin, sea vegetables, nutritive oils, moisturizing oils, vegetable butters, propylene glycol, parabens, honey, bees wax, aloe, polysorbate, cornstarch, cocoa powder, coral powder, humectants, gums, emulsifying agents, and thickeners. In one ~~embodiment~~example, the mixture is packaged as a cosmetics product. In another ~~embodiment~~example, the cosmetic product comprises a facial cleanser.

[0029] In some ~~embodiments~~examples of the saponification method, the ratio of fatty acid salts to the biomass from which they are separated is between 10% fatty acid salts to 90% biomass and 90% fatty acid salts to 10% biomass by dry weight. In some methods, the biomass is subjected to the alkaline hydrolysis reaction without a step of prior enrichment that increases a ratio of lipid to non-lipid material in the biomass by more than 50% by weight. In some

methods, the harvested biomass is not subjected to treatments other than lysis before the alkaline hydrolysis reaction. In other methods, the biomass is subjected to the alkaline hydrolysis reaction with a step of prior enrichment that increases the ratio of lipid to non-lipid material in the biomass as compared to the ratio at harvesting. In some ~~embodiments~~examples, the biomass subjected to the alkaline hydrolysis reaction contains components other than water in the same relative proportions as the biomass at harvesting. In some ~~embodiments~~examples, lipid comprises no more than 90% of the biomass subjected to the alkaline hydrolysis reaction.

[0030] In some ~~embodiments~~examples of the saponification method, the harvested biomass comprises a lipid content of at least 5%, at least 10%, at least 15%, at least 20%, at least 25%, at least 30%, at least 35%, at least 40%, at least 45%, at least 50%, at least 55%, at least 60%, at least 65%, at least 70%, at least 75%, at least 80%, at least 85%, or at least 90% by DCW. In some ~~embodiments~~examples, the lipid comprises at least 50%, at least 60%, at least 70%, at least 80%, at least 90%, or at least 95% saturated fatty acid constituents.

[0031] In some ~~embodiments~~examples, the saponification method further comprises disrupting the biomass prior to subjecting the biomass to the alkaline hydrolysis reaction. In some ~~embodiments~~examples, disrupting the biomass comprises mechanically lysing the population of microbes to generate a lysate. In some ~~embodiments~~examples, the oil is extracted from the biomass before saponification. In some ~~embodiments~~examples, the extracted oil is substantially free of color or pigments.

[0032] In another ~~aspect~~example, the present ~~invention~~disclosure is directed to a composition comprising a lighter phase containing fatty acid alkyl esters, and at least one heavier phase containing microbial biomass.

[0033] In various ~~embodiments~~examples of the composition, at least 20% of the fatty acid alkyl esters are C18. In some ~~embodiments~~examples, at least 30% of the fatty acid alkyl esters are C18. In some ~~embodiments~~examples, at least 40% of the fatty acid alkyl esters are C18. In some ~~embodiments~~examples, at least 50% of the fatty acid alkyl esters are C18. In some ~~embodiments~~examples, at least 50% of the fatty acid alkyl esters are C16 or longer chain lengths. In some ~~embodiments~~examples, at least 10% of the fatty acid alkyl esters are C14 or shorter chain lengths. In some ~~embodiments~~examples., at least 20% of the fatty acid alkyl esters are C14 or shorter chain lengths.

[0034] In another ~~aspect~~example, the present ~~invention~~disclosure is directed to a composition comprising a lighter phase containing completely saturated lipids and at least one heavier phase containing microbial biomass. In another ~~aspect~~example, the present ~~invention~~disclosure is directed to a composition comprising a lighter phase containing lipids and at least one heavier phase containing

microbial biomass from more than one species or strain. In another ~~aspect~~example, the present ~~invention~~disclosure is directed to a composition comprising a lighter phase containing hydroxylated lipids,and at least one heavier phase containing microbial biomass. In another ~~aspect~~example, the present ~~invention~~disclosure is directed to a composition comprising a lighter phase containing free fatty acids and at least one heavier phase containing microbial biomass.

[0035] In another ~~aspect~~example, the present ~~invention~~disclosure is directed to a composition comprising saponified oil derived from the alkaline hydrolysis of biomass produced by culturing a population of microbes. In some ~~embodiments~~examples, the composition further comprises at least one and optionally more than one oil selected from the group of oils consisting of soy, rapeseed, canola, palm, palm kernel, coconut, corn, waste vegetable, Chinese tallow, olive, sunflower, cotton seed. chicken fat, beef tallow, porcine tallow, microalgae, macroalgae, Cuphea, flax, peanut, choice white grease, lard, Camelina sativa, mustard seed cashew nut, oats, lupine, kenaf, calendula, hemp, coffee, linseed (flax), hazelnut, euphorbia, pumpkin seed, coriander, camellia, sesame, safflower, rice, tung oil tree, cocoa, copra, pium poppy, castor beans, pecan, jojoba, jatropha, macadamia, Brazil nuts, avocado, a fossil oil or a distillate fraction thereof.

[0036] In various ~~embodiments~~examples, the saponified oil composition can be a solid (including a powder), or a liquid. In some ~~embodiments~~examples, the composition further comprises carotenoids derived from the biomass, and/or unsaponified glycerolipids derived from the biomass, and/or polysaccharides derived from the biomass. In some ~~embodiments~~examples, the saponified oil comprises at least 50% of the composition's total mass. In some ~~embodiments~~examples, the saponified oil comprises at least 75% of the composition's total mass. In other ~~embodiments~~examples, the saponified oil comprises less than 50% of the composition's total mass. In other ~~embodiments~~examples, the saponified oil comprises less than 25% of the composition's total mass. In some ~~embodiments~~examples, components derived from the biomass constitute at least 50% of the composition's total mass. In some ~~embodiments~~examples, components derived from the biomass constitute no more than 50% of the composition's total mass.

[0037] In another ~~aspect~~example, the present ~~invention~~disclosure is directed to a kit comprising a saponified oil composition as described herein and an oral supplement. In some ~~embodiments~~examples, the oral supplement comprises a vitamin or an herb.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] Figure 1 shows DCW per liter of multiple species and strains of *Chlorella* when cultured in the presence of various types of glycerol with and without additional glucose.

WHAT IS CLAIMED IS:

1. A method of making a chemically modified lipid, comprising:

(a) providing a microalgal lipid comprising no more than 500 ppm color-generating impurities, wherein the lipid is obtained from microalgae cultured under heterotrophic growth conditions in a bioreactor substantially in the absence of light; and

(b) subjecting the microalgal lipid to a chemical reaction to produce the modified lipid, wherein the chemical reaction is selected from one or more of esterification, transesterification, interesterification, hydrogenation, hydroxylation, cyclopropanation, epoxidation, deoxygenation, and isomerization,

wherein the microalgae are selected from strains *Parachlorella, Prototheca, Chlorella* and strains having at least 85% nucleotide sequence identity in 23S rRNA sequences to a *Parachlorella, Prototheca,* or *Chlorella* strain.

2. The method of claim 1, wherein the microalgal lipid is obtained from microalgae cultured on sucrose.

3. The method of claim 2, wherein the microalgal lipid is obtained from microalgae cultured on sorghum, sugar cane, sugar beet, or molasses.

4. The method of claim 1, wherein the microalgal lipid is obtained from microalgae cultured on glucose.

5. The method of claim 1, wherein at least 10% of the microalgal or modified lipid is C14 or a lipid of shorter chain length.

6. The method of claim 1, wherein at least 20% of the microalgal or modified lipid is C14 or a lipid of shorter chain length.

7. The method of claim 1, wherein at least 50% of the microalgal or modified lipid is C16 or a lipid of longer chain lengths.

8. The method of claim 1, wherein at least 20% of the microalgal or modified lipid is C18.

9. The method of claim 1, wherein at least 30% of the microalgal or modified lipid is C18.

10. The method of claim 1, wherein at least 40% of the microalgal or modified lipid is C18.

11. The method of claim 1, wherein at least 50% of the microalgal or modified lipid is C18.

12. The method of claim 1, wherein the one or more chemical reactions comprise hydrogenation or hydroxylation.

13. The method of claim 1, wherein the one or more chemical reactions comprise esterification, transesterification, or interesterification.

14. The method of claim 1, wherein the modified lipid is further blended with at least one oil selected from soy, rapeseed, canola, palm, palm kernel, coconut, corn, waste vegetable, Chinese tallow, olive, sunflower, cotton seed, chicken fat, beef tallow, porcine tallow, microalgae, macroalgae, Cuphea, flax, peanut, choice white grease, lard, *Camelina sativa*, mustard seed, cashew nut, oats, lupine, kenaf, calendula, hemp, coffee, linseed (flax), hazelnut, euphorbia, pumpkin seed, coriander, camellia, sesame, safflower, rice, tung oil tree, cocoa, copra, opium poppy, castor beans, pecan, jojoba, jatropha, macadamia, Brazil nuts, avocado, and a fossil oil or a distillate fraction thereof.

15. The method of claim 1, wherein the modified lipid is further blended with one or more additives selected from the group consisting of essential oils, fragrance oils, flavor oils, botanicals, extracts, CO_2 extracts, clays, colorants, titanium dioxide, micas, tinting herbs, glitters, exfoliants, fruit seeds, fibers, grain powders, nut meals, seed meals, oil beads, wax beads, herbs, hydrosols, vitamins, milk powders, preservatives, antioxidants, tocopherols, salts, sugars, vegetable oils, waxes, glycerin, sea vegetables, nutritive oils, moisturizing oils, vegetable butters, propylene glycol, parabens, honey, bees wax, aloe, polysorbate, cornstarch, cocoa powder, coral powder, humectants, gums, emulsifying agents, and thickeners.

16. The method of claim 1, wherein the microalgae is *Chlorella*.

17. The method of claim 1, wherein the microalgae is *Parachlorella*.

18. The method of claim 1, wherein the microalgae is incapable of performing photosynthesis.

19. The method of claim 18, wherein the microalgae is *Prototheca.*

20. The method of claim 19, wherein the microalgae is selected from the group consisting of *Prototheca wickerhamii, Prototheca stagnora, Prototheca portoricensis, Prototheca moriformis,* and *Prototheca zopfii.*

21. The method of claim 20, wherein the microalgae is *Prototheca moriformis.*

22. A method of making a chemical comprising: (a) providing biomass obtained from a population of lysed oleaginous microbial cells, the oleaginous microbial cells comprising more than 10% lipid by dry cell weight prior to lysis, and (b) subjecting the biomass to a chemical reaction that covalently modifies the biomass, wherein the chemical reaction is selected from one or more of esterification, transesterification, interesterification, hydrogenation, hydroxylation, cyclopropanation, epoxidation, deoxygenation, and isomerization.

23. The method of claim 22, wherein the lysed oleaginous microbial cells have at least 30% lipid by dry cell weight prior to lysis.

24. The method of claim 22, wherein the lysed oleaginous microbial cells have at least 40% lipid by dry cell weight prior to lysis.

25. The method of claim 22, wherein the lysed oleaginous microbial cells have at least 50% lipid by dry cell weight prior to lysis.

26. The method of claim 22, wherein the lysed oleaginous microbial cells have at least 60% lipid by dry cell weight prior to lysis.

27. The method of claim 22, wherein the biomass comprises cell wall or cellular membranes of the lysed oleaginous microbial cells.

28. The method of claim 27, wherein the biomass comprises polysaccharides.

29. The method of claim 22, wherein the oleaginous microbial cells are lysed mechanically, enzymatically, virally, or by sonication or osmotic shock.

30. The method of claim 22, wherein the one or more chemical reactions comprise esterification, transesterification, or interesterification.

31. The method of claim 22, wherein the chemical is further blended with one or more additives selected from the group consisting of essential oils, fragrance oils, flavor oils, botanicals, extracts, CO_2 extracts, clays, colorants, titanium dioxide, micas, tinting herbs, glitters, exfoliants, fruit seeds, fibers, grain powders, nut meals, seed meals, oil beads, wax beads, herbs, hydrosols, vitamins, milk powders, preservatives, antioxidants, tocopherols, salts, sugars, vegetable oils, waxes, glycerin, sea vegetables, nutritive oils, moisturizing oils, vegetable butters, propylene glycol, parabens, honey, bees wax, aloe, polysorbate, cornstarch, cocoa powder, coral powder, humectants, gums, emulsifying agents, and thickeners.

32. The method of claims 22, wherein the oleaginous microbial cells are selected from the group consisting of bacteria, cyanobacteria, microalgae, yeast, and fungi.

33. The method of claim 32, wherein the oleaginous microbial cells are microalgae.

34. The method of claim 33, wherein the microalgae are selected from strains *Parachlorella, Prototheca, Chlorella* and strains having at least 85% nucleotide sequence identity in 23S rRNA sequences to a *Parachlorella, Prototheca,* or *Chlorella* strain.

35. The method of claim 33, wherein the microalgae are cultured under heterotrophic growth conditions in a bioreactor substantially in the absence of light

36. The method of claim 33, wherein the microalgae are cultured on sorghum, sugar cane, sugar beet, or molasses.

37. The method of claim 33, wherein the microalgae are cultured on glucose.

38. The method of claim 33, wherein the microalgae are *Chlorella.*

39. The method of claim 33, wherein the microalgae are incapable of performing photosynthesis.

40. The method of claim 39, wherein the microalgae are *Prototheca wickerhamii, Prototheca stagnora, Prototheca portoricensis, Prototheca moriformis,* or *Prototheca zopfii.*

41. A chemical prepared by the process of: (a) providing biomass obtained from a population of lysed oleaginous microbial cells, the oleaginous microbial cells comprising more than 10% lipid by dry cell weight prior to lysis, and (b) subjecting the biomass to a chemical reaction that covalently modifies the biomass, wherein the chemical reaction is selected from one or more of esterification, transesterification, interesterification, hydrogenation, hydroxylation, cyclopropanation, epoxidation, deoxygenation, and isomerization.

42. A method of chemically modifying lipid-containing microalgal biomass comprising:

(a) culturing a population of microalgae;

(b) harvesting microalgal biomass, wherein the microalgal biomass contains at least 5% lipid by dry cell weight, and no more than 500 ppm color-generating impurities; and

(c) subjecting the lipid-containing microalgal biomass to a chemical reaction that covalently modifies at least 1% of the lipid, wherein the chemical reaction is selected from one or more of transesterification, interesterification, hydrogenation, hydroxylation, cyclopropanation, epoxidation, deoxygenation, and isomerization.

43. The method of claim 42, wherein the chemical reaction is transesterification.

44. The method of claim 42, wherein the chemical reaction is epoxidation.

45. The method of claim 42, wherein the chemical reaction is one or more of hydrogenation, interesterification, and hydroxylation.

46. The method of claim 42, wherein the chemical reaction is hydroprocessing and deoxygenation, optionally followed by isomerization.

47. The method of claim 42 or 43, further comprising disrupting the biomass prior to subjecting the biomass to the chemical reaction.

48. The method of claim 42, wherein step (c) includes contacting the biomass with an enzyme to catalyze the chemical reaction.

49. The method of any one of claims 42 to 48, wherein the microalgae are of the genus *Chlorella* or the genus *Prototheca*.

50. The method of claim 49, wherein the microalgae are a species selected from the group consisting of *Chlorella fusca, Chlorella protothecoides, Chlorella pyrenoidosa, Chlorella kessleri, Chlorella vulgaris, Chlorella saccharophila, Chlorella sorokiniana*, and *Chlorella ellipsoidea.*

51. The method of claim 49, wherein the microalgae are a species selected from the group consisting of *Prototheca wickerhamii, Prototheca stagnora, Prototheca portoricensis, Prototheca moriformis,* and *Prototheca zopfii.*

WHAT IS CLAIMED IS:

1. A method of making a chemically modified lipid, comprising:

(a) providing a microalgal lipid comprising no more than 500 ppm color-generating impurities, wherein the lipid is obtained from microalgae cultured under heterotrophic growth conditions in a bioreactor substantially in the absence of light; and

(b) subjecting the microalgal lipid to a chemical reaction to produce the modified lipid,

wherein the microalgae are selected from strains of *Parachlorella, Prototheca,* or *Chlorella* or strains having at least 85% nucleotide sequence identity in 23S rRNA sequences to a *Parachlorella, Prototheca,* or *Chlorella* strain.

2. The method of claim 1, wherein the microalgal lipid is obtained from microalgae cultured on sucrose.

3. The method of claim 2, wherein the microalgal lipid is obtained from microalgae cultured on sorghum, sugar cane, sugar beet, or molasses.

4. The method of claim 1, wherein the microalgal lipid is obtained from microalgae cultured on glucose.

5. The method of claim 2, wherein at least 10% of the microalgal or modified lipid is C14 or a lipid of shorter chain length.

6. The method of claim 2, wherein at least 20% of the microalgal or modified lipid is C14 or a lipid of shorter chain length.

7. The method of claim 2, wherein at least 50% of the microalgal or modified lipid is C16 or a lipid of longer chain lengths.

8. The method of claim 2, wherein at least 20% of the microalgal or modified lipid is C18.

9. The method of claim 2, wherein at least 30% of the microalgal or modified lipid is C18.

10. The method of claim 2, wherein at least 40% of the microalgal or modified lipid is C18.

11. The method of claim 2, wherein at least 50% of the microalgal or modified lipid is C18.

12. The method of claim 2, wherein the one or more chemical reactions comprise an esterification, transesterification, interesterification, hydrogenation, hydroxylation, cyclopropanation, epoxidation, deoxygenation, isomerization, or hydrolysis.

13. The method of claim 2, wherein the one or more chemical reactions comprise an esterification, transesterification, interesterification, hydrogenation, or hydroxylation.

14. The method of claim 2, wherein the modified lipid is further blended with at least one oil selected from soy, rapeseed, canola, palm, palm kernel, coconut, corn, waste vegetable, Chinese tallow, olive, sunflower, cotton seed, chicken fat, beef tallow, porcine tallow, microalgae, macroalgae, Cuphea, flax, peanut, choice white grease, lard, *Camelina sativa*, mustard seed, cashew nut, oats, lupine, kenaf, calendula, hemp, coffee, linseed (flax), hazelnut, euphorbia, pumpkin seed, coriander, camellia, sesame, safflower, rice, tung oil tree, cocoa, copra, opium poppy, castor beans, pecan, jojoba, jatropha, macadamia, Brazil nuts, avocado, and a fossil oil or a distillate fraction thereof.

15. The method of claim 2, wherein the modified lipid is further blended with one or more additives selected from the group consisting of essential oils, fragrance oils, flavor oils, botanicals, extracts, CO_2 extracts, clays, colorants, titanium dioxide, micas, tinting herbs, glitters, exfoliants, fruit seeds, fibers, grain powders, nut meals, seed meals, oil beads, wax beads, herbs, hydrosols, vitamins, milk powders, preservatives, antioxidants, tocopherols, salts, sugars, vegetable oils, waxes, glycerin, sea vegetables, nutritive oils, moisturizing oils, vegetable butters, propylene glycol, parabens, honey, bees wax, aloe, polysorbate, cornstarch, cocoa powder, coral powder, humectants, gums, emulsifying agents, and thickeners.

16. The method of claim 2, wherein the microalgae is *Chlorella*.

17. The method of claim 2, wherein the microalgae is *Parachlorella*.

18. The method of claim 2, wherein the microalgae is incapable of performing photosynthesis.

19. The method of claim 18, wherein the microalgae is *Prototheca*.

20. The method of claim 19, wherein the microalgae is selected from the group consisting of *Prototheca wickerhamii, Prototheca stagnora, Prototheca portoricensis, Prototheca moriformis,* and *Prototheca zopfii.*

21. The method of claim 20, wherein the microalgae is *Prototheca moriformis*.