profit margin as possible, it is necessary to decrease the time, energy consumption and oil loss during refining. The prior art methods do not offer the most efficient technologies for purifying oils in the shortest amount of time possible. As a result, the demand exists for an advanced method for the prompt removal of phytosterols and phospholipids from oil at low energy and agent cost resulting in products with advanced qualities, preferably using the flow-through cavitation . The present invention provides such method while delivering purified oil within a very short processing time. No accumulation of waste material harmful to the environment occurs, and the produced residual concentrates are suitable for downstream processing.

[Para 17] The invention provides an oil purification method based on generating cavitation in an oil flow within at least one cavitation apparatus' chamber, preferably in a number of the consecutively placed chambers. This goal is achieved through the application of cavitation apparatuses aimed at the express purification of oils. In accordance with the present invention, the method comprises feeding a fluidic mixture of oil and agent in the flow-through hydrodynamic cavitation device using a preset inlet pressure sustained by a pump and applying selected conditions and additional agents, if required.

SUMMARY ~~OF THE INVENTION~~

[Para 17a] In accordance with one aspect, there is provided a process to remove impurities from triacylglycerol oil, comprising the steps of: mixing the oil and a

fluidic agent to form a fluidic mixture having an oil phase and a water phase; pumping the fluidic mixture through a single- or multi-stage, flow-through hydrodynamic cavitation apparatus; creating hydrodynamic cavitation in the fluidic mixture by pumping the fluidic mixture at a pre-determined inlet pump pressure; maintaining the hydrodynamic cavitation in the fluidic mixture for a pre-determined period of time; moving the impurities from the oil phase to the water phase; and separating the water phase from the oil phase.

[Para 18] The present ~~invention~~ disclosure is directed to the method of processing TAG oil, fat, tallow and grease with a single- or multi-stage flow-through

[Para 23] The present ~~invention~~ disclosure is directed to a process to remove impurities from triacylglycerol oil. The process begins with mixing the oil and a fluidic agent to form a fluidic mixture having an oil phase and a water phase. This fluidic mixture is then pumped through a single- or multi-stage, flow-through hydrodynamic cavitation apparatus. In this apparatus, hydrodynamic cavitation is created in the fluidic mixture by pumping the fluidic mixture at a predetermined inlet pump pressure. The hydrodynamic cavitation is maintained in the fluidic mixture for a pre-determined period of time. During the hydrodynamic cavitation, the impurities are moved from the oil phase to the water phase. Finally, the water phase containing the impurities is separated from the oil phase.

[Para 24] In this inventiondisclosure, the oil can include oil, fat, tallow or grease derived from a wild type, mutated or genetically altered unicellular or multicellular algae, plant, animal or mixture thereof. The oil may be crude, refined, pressed, extracted, filtrated, or dewatered. In addition, the oil may be liquefied prior to performing the mixing step. The oil may also be a multiphase blend of immiscible liquids, solutes, acids, bases, salts, or gasses comprising a dispersion, an emulsion, a suspension, a melted solid, a gas in a supercritical condition or a mixture thereof.

[Para 25] The flow-through hydrodynamic cavitation apparatus preferably comprises a high-energy, jet collision hydrodynamic cavitation apparatus or a spinning, rotor-stator hydrodynamic cavitation apparatus.

to the liquefied phosphatides; releasing entrapped oils in the liquefied phosphatides.

[Para 37] The present ~~invention~~ disclosure is also directed to a method of generating cavitation in a flow mixture of oil and agent resulting in the production of oil refined of ASG, SG and phosphorus. This goal is achieved through the design of the cavitation apparatuses aimed to expedite purification followed by separating the impurity-enriched residue from oil. In accordance with the present inventionan embodiment, the method comprises feeding liquid oil and agent solution or a mixture thereof into the flow-through hydrodynamic single- or multistage cavitation apparatus with a pump and controlling cavitation by varying the inlet pump pressure, and continuing the application of such treatment for a period of time sufficient to obtain the refined oil. The term oil includes, but is not limited to homogeneous or heterogeneous triacylglycerol oil, fat, tallow and grease existing in a liquid phase prior to cavitation, produced by wild type, mutated or genetically engineered bacteria, yeast, algae, plant(s), animals, bird, fish and other prokaryotes or eukaryotes, a two-phase or a multi-phase system comprised of oil, water and/or other immiscible liquids, solution of salts, acids, bases, enzymes, gases and/or other solutes, dispersions, emulsions, suspensions, melted solids, gases in a supercritical state and mixtures thereof. The fluid may be heated, cooled, degassed or saturated with nitrogen, carbon dioxide and other gas or mixtures thereof.

What is claimed is:

[Claim 1] A process to remove impurities ~~comprising phytosterols, sterol glucosides and/or acylated sterol glucosides~~ from triacylglycerol oil, comprising the steps of:

mixing the oil and a fluidic agent to form a fluidic mixture having an oil phase and a water phase~~, wherein the fluidic agent is water comprising 0.1–10% v/v of the fluidic mixture~~;

pumping the fluidic mixture through a single- or multi-stage, flow-through hydrodynamic cavitation apparatus;

creating hydrodynamic cavitation in the fluidic mixture by pumping the fluidic mixture at a pre-determined inlet pump pressure;

maintaining the hydrodynamic cavitation in the fluidic mixture for a pre-determined period of time;

moving the impurities ~~comprising phytosterols, sterol glucosides and/or acylated sterol glucosides~~ from the oil phase to the water phase; and

separating the water phase from the oil phase.

[Claim 2] The process of claim 1, wherein the oil includes oil, fat, tallow or grease derived from a wild type, mutated or genetically altered unicellular or multicellular algae, plant, animal or mixture thereof.

[Claim 14] The process of claim 1, further comprising the step of immobilizing reagents, oxides, nitrides, ceramics, plastics, polytetrafluoroethylene, nanodiamonds, nanotubes, or combinations thereof onto inner walls of the hydrodynamic cavitation apparatus or onto a removable insert configured for insertion into the hydrodynamic cavitation apparatus.

[Claim 15] The process of claim 1, further comprising the step of placing a selective membrane and/or bleaching earth in an end chamber of the hydrodynamic cavitation apparatus or in a chamber located downstream of the hydrodynamic cavitation apparatus.

[Claim 16] The process of claim 1, wherein the oil is degassed prior to performing the pumping, creating and/or maintaining steps.

[Claim 17] The process of claim 1, further comprising the step of subjecting the fluidic mixture to acoustic cavitation.

[Claim 18] The process of claim 1, further comprising the step of subjecting the fluidic mixture to an external electric and/or magnetic field to enhance hydrodynamic cavitation-assisted purification.

[Claim 19] The process of claim 1, wherein the impurities comprise phytosterols, sterol glucosides and/or acylated sterol glucosides.

[Claim 20] The process of claim 19, wherein the fluidic agent is water comprising 0.1-10% v/v of the fluidic mixture.

[Claim ~~19~~21] The process of claim ~~1~~20, wherein the water is distilled, de-ionized, reverse osmosis-purified, soft water or conditioned water.

[Claim ~~20~~22] The process of claim ~~1~~19, wherein the fluidic agent is a solution of an alkali hydroxide comprising sodium hydroxide or potassium hydroxide, an inorganic base, an organic base or a mixture thereof.

[Claim ~~21~~23] The process of claim ~~1~~19, wherein the fluidic agent is a solution of phosphoric acid, citric acid, acetic acid or a mixture thereof.

[Claim ~~22~~24] The process of claim ~~1~~19, wherein the separating step, as it relates to phytosterol impurities, is carried out contemporaneously with the maintaining step.

[Claim ~~23~~25] The process of claim ~~1~~19, wherein the separating step, as it relates to sterol glucosides, acylated sterol glucosides and/or derivative-enriched concentrates of the same, further comprises the steps of:

liquefying the separated sterol glucosides, acylated sterol glucosides and/or derivative-enriched concentrates thereof by preheating and/or treating the same with solvents and/or liquefying agents;

adding enzymes or chemical agents to the liquefied sterol glucosides, acylated sterol glucosides and/or derivative-enriched concentrates thereof; subjecting the liquefied sterol glucosides, acylated sterol glucosides and/or derivative-enriched concentrates thereof combined with enzymes or chemical agents to flow-through hydrodynamic cavitation; and releasing entrapped oil in the liquefied sterol glucosides, acylated sterol glucosides and/or derivative-enriched concentrates thereof.

~~[Claim 24] A process to remove impurities comprising phosphatides from triacylglycerol oil, comprising the steps of: mixing the oil and a fluidic agent comprising water to form a fluidic mixture having an oil phase and a water phase;~~

~~pumping the fluidic mixture through a single- or multi-stage, flow-through hydrodynamic cavitation apparatus;~~

~~creating hydrodynamic cavitation in the fluidic mixture by pumping the fluidic mixture at a pre-determined inlet pump pressure;~~

~~maintaining the hydrodynamic cavitation in the fluidic mixture for a pre-determined period of time;~~

~~adding an enzyme comprising a phospholipase, a lipid acyltransferase or a mixture thereof to the fluidic mixture following the hydrodynamic cavitation;~~

~~reacting the phosphatides with the enzyme;~~

~~agitating the fluidic mixture for a pre-determined period of time so as to allow for completion of the reaction between the phosphatides and the enzyme;~~

~~moving the impurities comprising phosphatides from the oil phase to the water phase; and separating the water phase from the oil phase, including removing the reacted phosphatides.~~

[Claim 26] The process of claim 1, wherein the impurities comprise phosphatides and the fluidic agent comprises water and an enzyme.

[Claim ~~25~~27] The process of claim ~~24~~26, wherein the fluidic mixture is heated or cooled to a temperature in the range of 40–60 °C for optimal enzyme activity.

[Claim 28] The process of claim 26, wherein the enzyme comprises a phospholipase, a lipid acyltransferase or a mixture thereof.

[Claim ~~26~~29] The process of claim ~~24~~28, wherein the phospholipase is a wild type, mutated or recombinant bacterial, yeast, plant or animal phospholipase A, phospholipase A1, phospholipase A2, phospholipase B, lysophospholipase,

phospholipase C, phospholipase D, phosphodiesterase, lipid acyltransferase, phosphodiesterase or mixture thereof.

[Claim 30] The process of claim 29, wherein the oil is mixed with water and the mixture is subjected to hydrodynamic cavitation followed by the addition of the phospolipase, lipid acyltransferase or mixture thereof.

[Claim 31] The process of claim 26, further comprising the steps of:

reacting the phosphatides in the fluidic mixture with the enzyme;

agitating the fluidic mixture for a pre-determined period of time to allow completion of the phosphatide reaction; and

stopping the phosphatide reaction.

~~[Claim 27] The process of claim 26, wherein the enzyme is kosher.~~

[Claim ~~28~~32] The process of claim ~~24~~31, ~~further comprising the step of stopping the~~wherein phosphatide reaction is stopped by heating; changing the pH; applying an inhibitor, protease or chelating agent that forms a complex with the enzyme's co-factor; carrying out high-shear mixing; ultrasonic cavitation; and/or subjecting to hydrodynamic cavitation.

[Claim 33] The process of claim 31, wherein the separating step comprises the step of removing the reacted phosphatides.

[Claim ~~29~~34] The process of claim ~~24~~33, wherein the reacted phosphatides are removed by absorption, centrifugation, decantation, extraction, filtration, freezing, membrane filtration, or sedimentation.

[Claim ~~30~~35] The process of claim ~~24~~33, wherein the separating step, as it relates to the removed phosphatides, further comprises the steps of:

liquefying the removed phosphatides by preheating the removed phosphatides, and/or adding solvents and liquefying agents to the removed phosphatides;

subjecting the liquefied phosphatides to flow-through hydrodynamic cavitation; and

releasing entrapped neutral oils and liberating diacylglycerols and fatty acids in the liquefied phosphatides.

[Claim ~~31~~36] The process of claim ~~24~~33, wherein the separating step, as it relates to the removed phosphatides, further comprises the steps of:

liquefying the removed phosphatides by preheating the removed phosphatides, and/or adding solvents and liquefying agents to the removed phosphatides;

adding releasing agents and/or lipid acyltransferase, lipase, phospholipase or a mixture thereof to the liquefied phosphatides; and

releasing entrapped oils in the liquefied phosphatides.

[Claim ~~32~~37] The process of claim ~~24~~26, further comprising the step of immobilizing the enzyme onto a removable cartridge, grid, filter, insert, inner surface, magnet, magnetic particles, metal particles, plastic particles, nanoparticles, nanotubes, nanodiamonds, carbonaceous nanoparticles, particles and/or carriers placed at desired locations within the hydrodynamic cavitation apparatus.