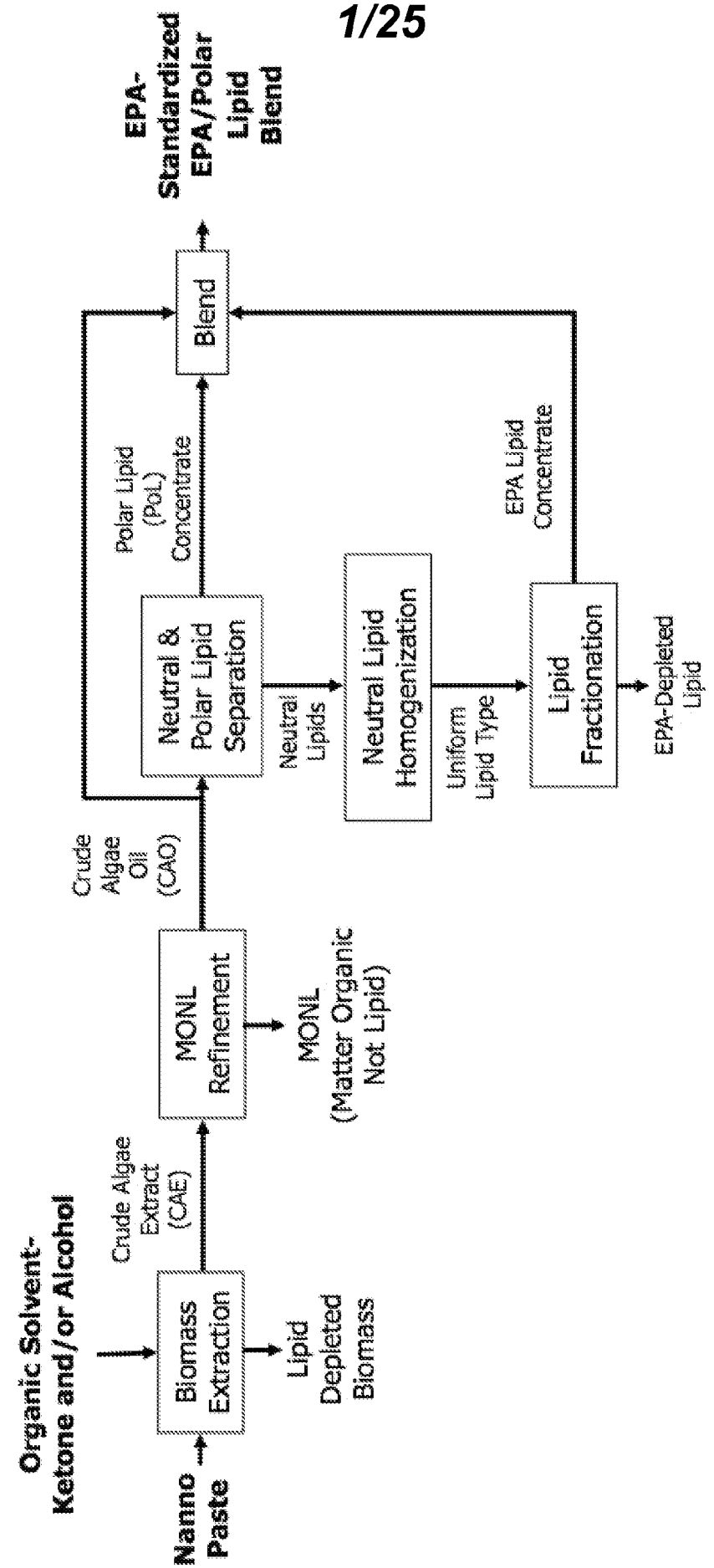

Nanno Paste
Organic Solvent-Ketone and/or Alcohol
Biomass Extraction
Lipid Depleted Biomass
Crude Algae Extract (CAE)
MONL Refinement
MONL (Matter Organic Not Lipid)
Crude Algae Oil (CAO)
Neutral & Polar Lipid Separation
Polar Lipid (PoL) Concentrate
Blend
EPA-Standardized EPA/Polar Lipid Blend
Neutral Lipids
Neutral Lipid Homogenization
Uniform Lipid Type
Lipid Fractionation
EPA Lipid Concentrate
EPA-Depleted Lipid

*Fig. 1*

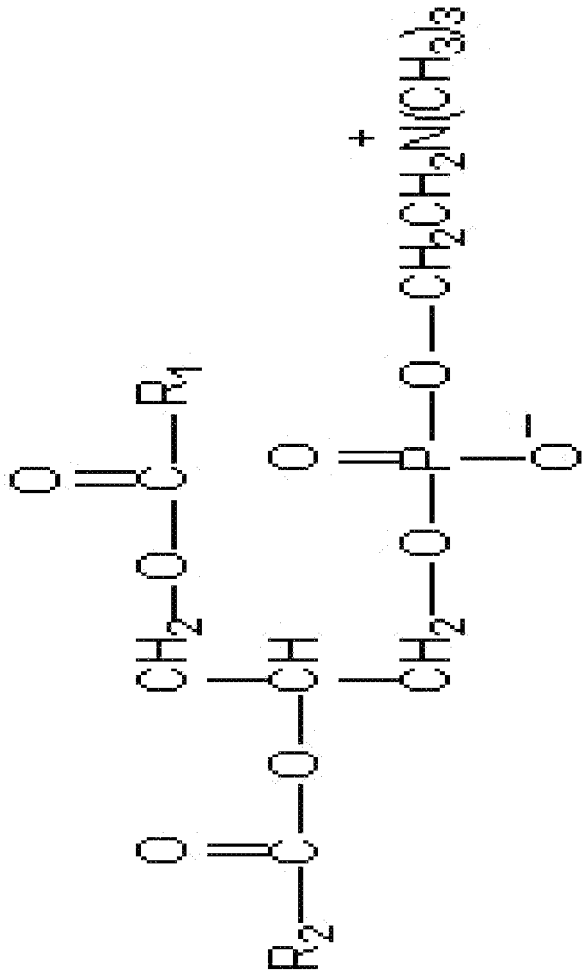
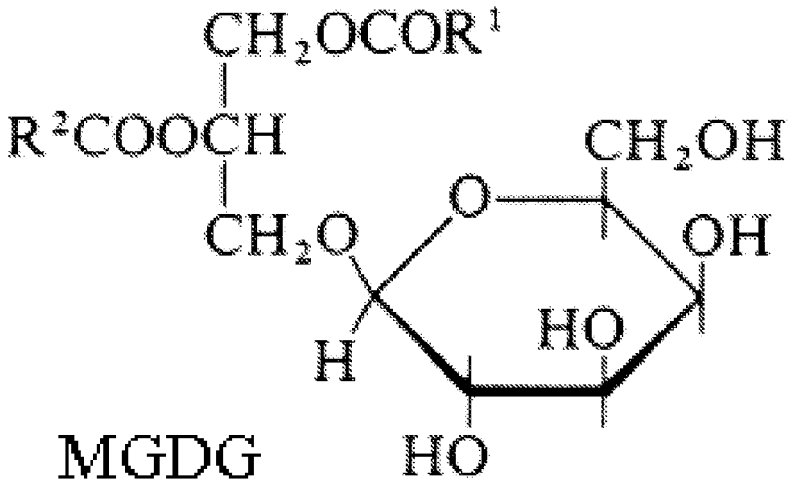


Fig. 2

A


CH2OCOR1
R2COOCH
CH2O
CH2OH
O
OH
H
HO
HO
MGDG

B

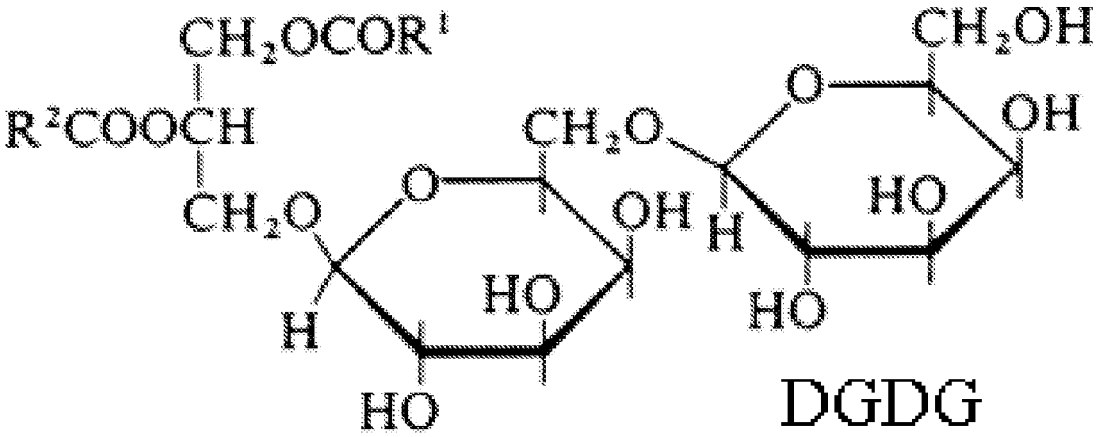

CH2OCOR1
R2COOCH
CH2O
O
CH2O
OH
H
HO
HO
CH2OH
O
OH
H
HO
HO
DGDG

Fig. 3

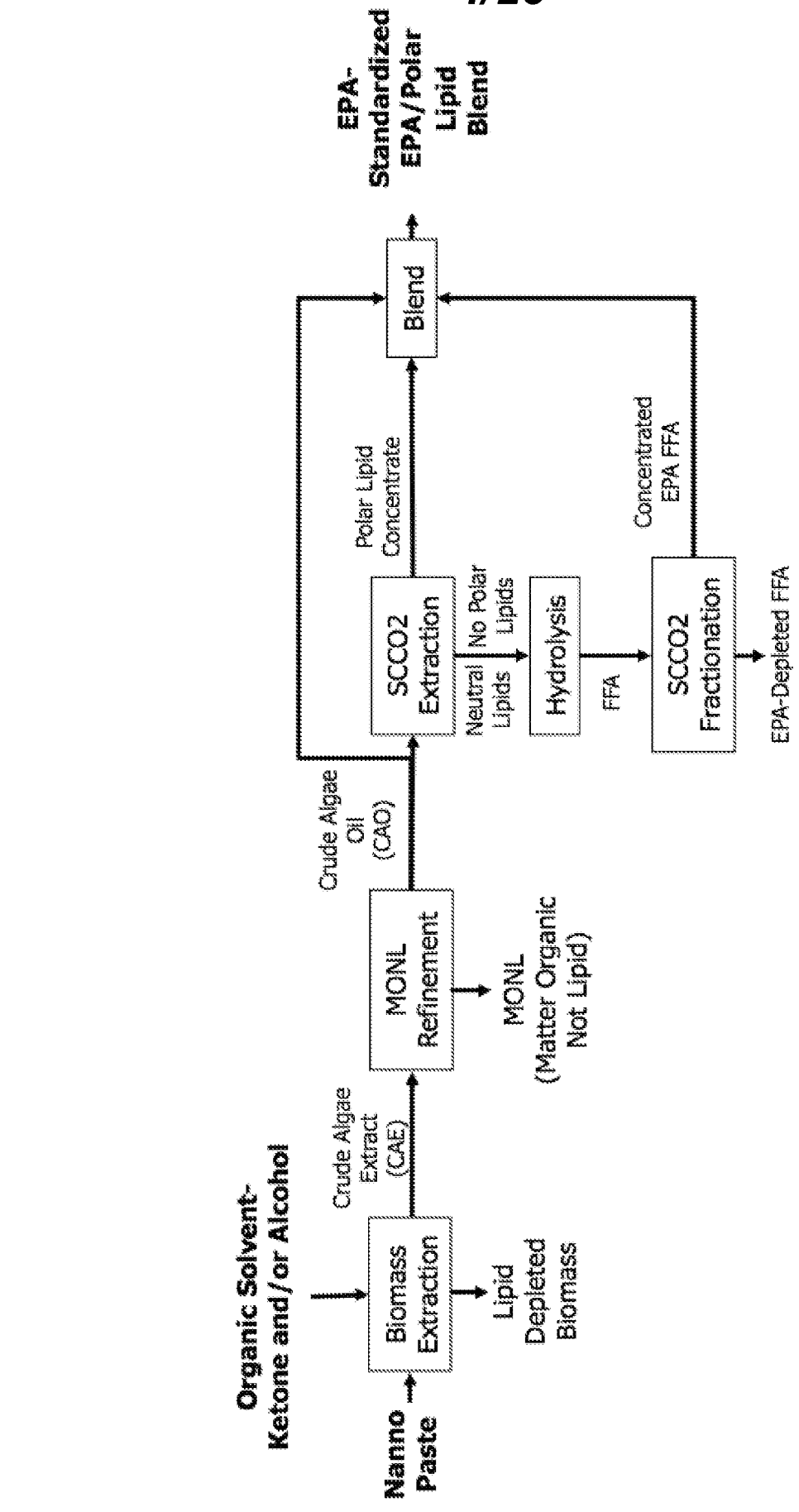

Nanno Paste
Organic Solvent-Ketone and/or Alcohol
Biomass Extraction
Lipid Depleted Biomass
Crude Algae Extract (CAE)
MONL Refinement
MONL (Matter Organic Not Lipid)
Crude Algae Oil (CAO)
SCCO2 Extraction
Neutral Lipids
No Polar Lipids
Hydrolysis
FFA
SCCO2 Fractionation
EPA-Depleted FFA
Concentrated EPA FFA
Polar Lipid Concentrate
Blend
EPA-Standardized EPA/Polar Lipid Blend

Fig. 4

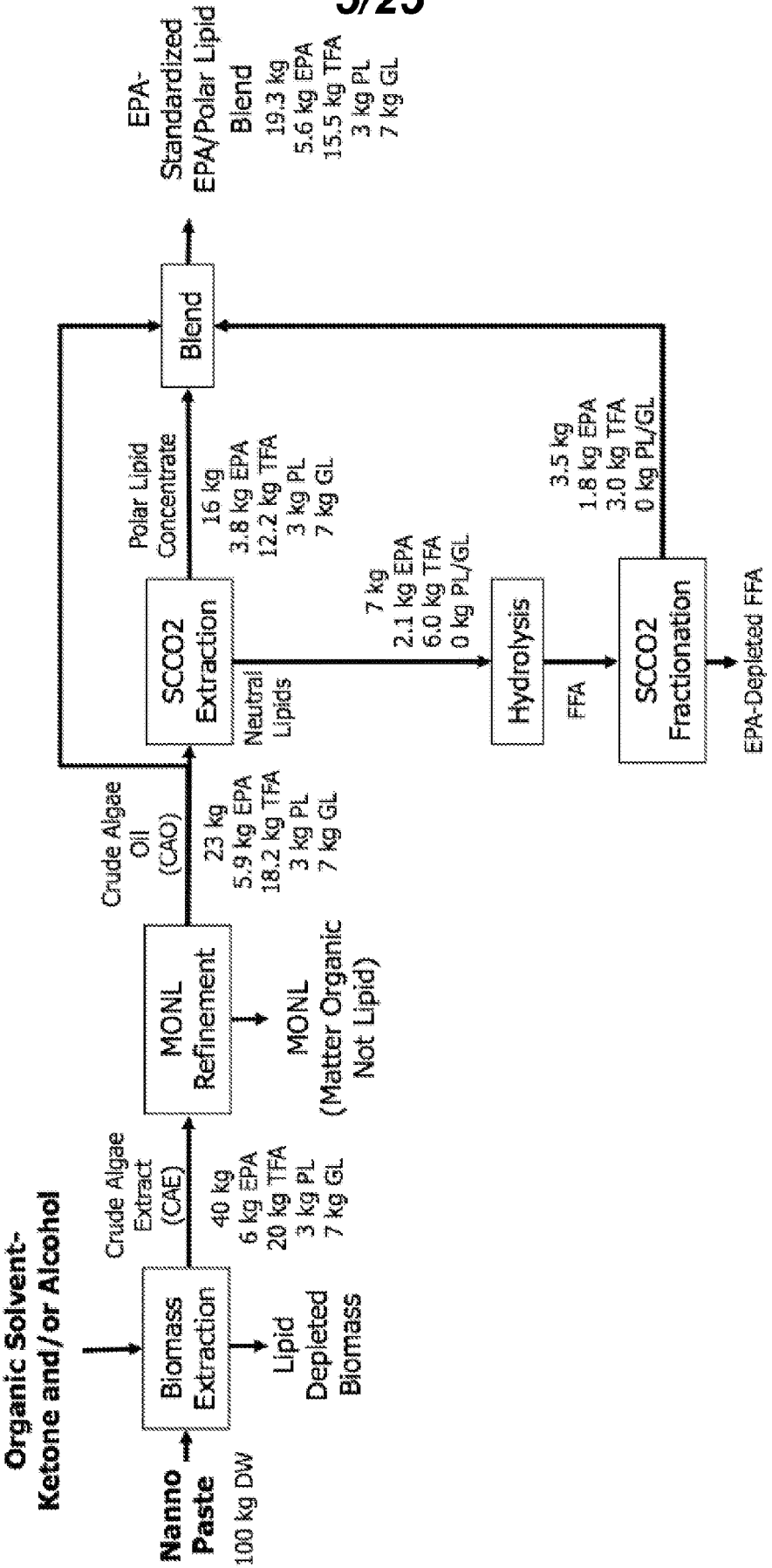

Organic Solvent-
Ketone and/or Alcohol
Nanno
Paste
100 kg DW
Biomass
Extraction
Lipid
Depleted
Biomass
Crude Algae
Extract
(CAE)
40 kg
6 kg EPA
20 kg TFA
3 kg PL
7 kg GL
MONL
Refinement
MONL
(Matter Organic
Not Lipid)
Crude Algae
Oil
(CAO)
23 kg
5.9 kg EPA
18.2 kg TFA
3 kg PL
7 kg GL
SCCO2
Extraction
Neutral
Lipids
7 kg
2.1 kg EPA
6.0 kg TFA
0 kg PL/GL
Hydrolysis
FFA
3.5 kg
1.8 kg EPA
3.0 kg TFA
0 kg PL/GL
SCCO2
Fractionation
EPA-Depleted FFA
Polar Lipid
Concentrate
16 kg
3.8 kg EPA
12.2 kg TFA
3 kg PL
7 kg GL
Blend
EPA-
Standardized
EPA/Polar Lipid
Blend
19.3 kg
5.6 kg EPA
15.5 kg TFA
3 kg PL
7 kg GL

*Fig. 5*

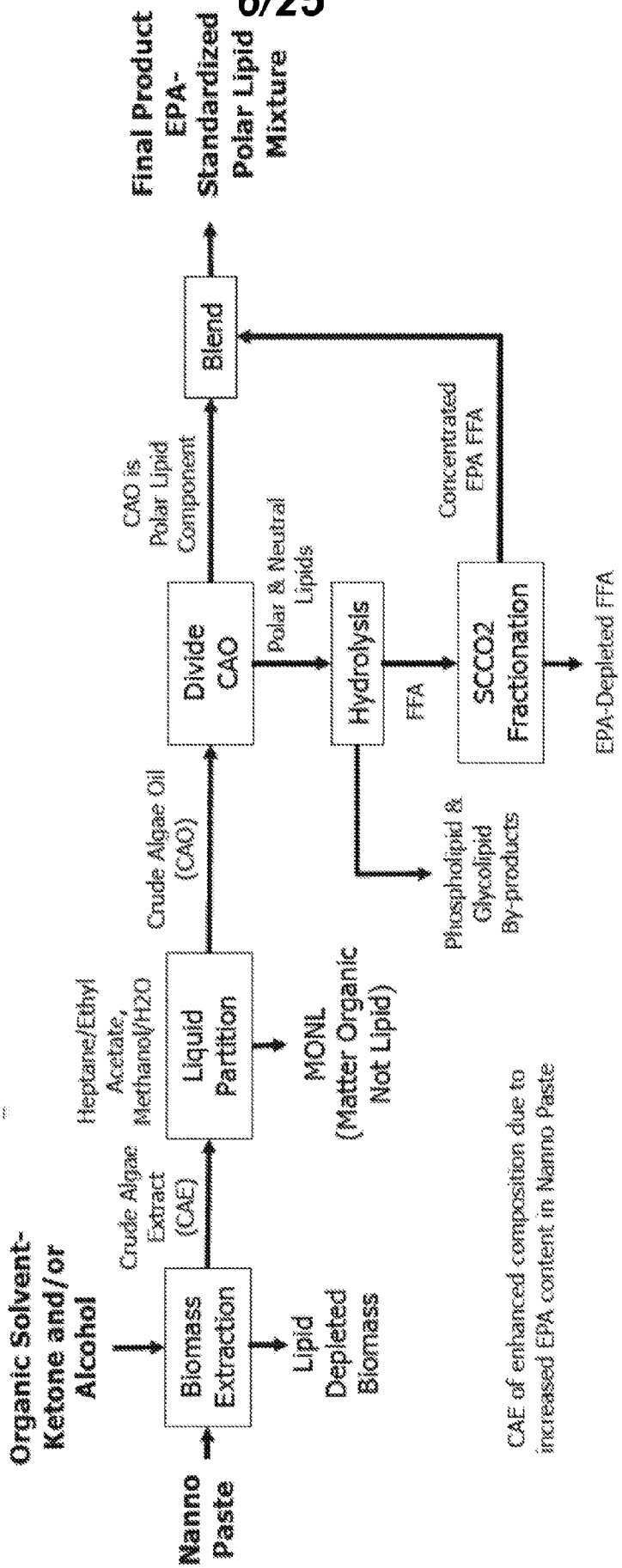

Nanno Paste
Organic Solvent-Ketone and/or Alcohol
Biomass Extraction
Crude Algae Extract (CAE)
Lipid Depleted Biomass
Heptane/Ethyl Acetate, Methanol/H2O
Liquid Partition
MONL (Matter Organic Not Lipid)
Crude Algae Oil (CAO)
Divide CAO
CAO is Polar Lipid Component
Blend
Final Product EPA-Standardized Polar Lipid Mixture
Polar & Neutral Lipids
Hydrolysis
FFA
Phospholipid & Glycolipid By-products
SCCO2 Fractionation
Concentrated EPA FFA
EPA-Depleted FFA
CAE of enhanced composition due to increased EPA content in Nanno Paste

*Fig. 6*

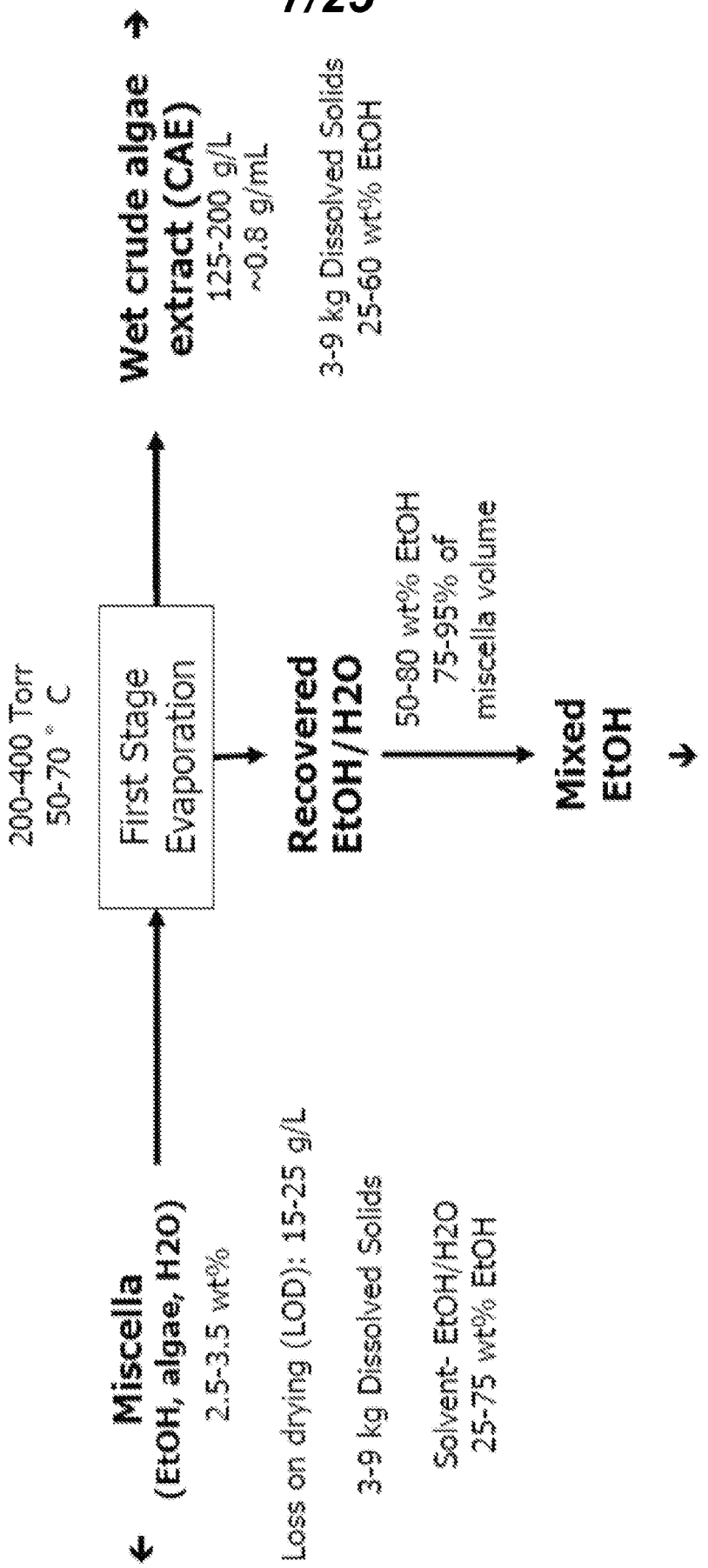

Miscella
(EtOH, algae, H2O)
2.5-3.5 wt%
Loss on drying (LOD): 15-25 g/L
3-9 kg Dissolved Solids
Solvent- EtOH/H2O
25-75 wt% EtOH
200-400 Torr
50-70 ° C
First Stage Evaporation
Recovered EtOH/H2O
50-80 wt% EtOH
75-95% of miscella volume
Mixed EtOH
Wet crude algae extract (CAE)
125-200 g/L
~0.8 g/mL
3-9 kg Dissolved Solids
25-60 wt% EtOH

*Fig. 7*

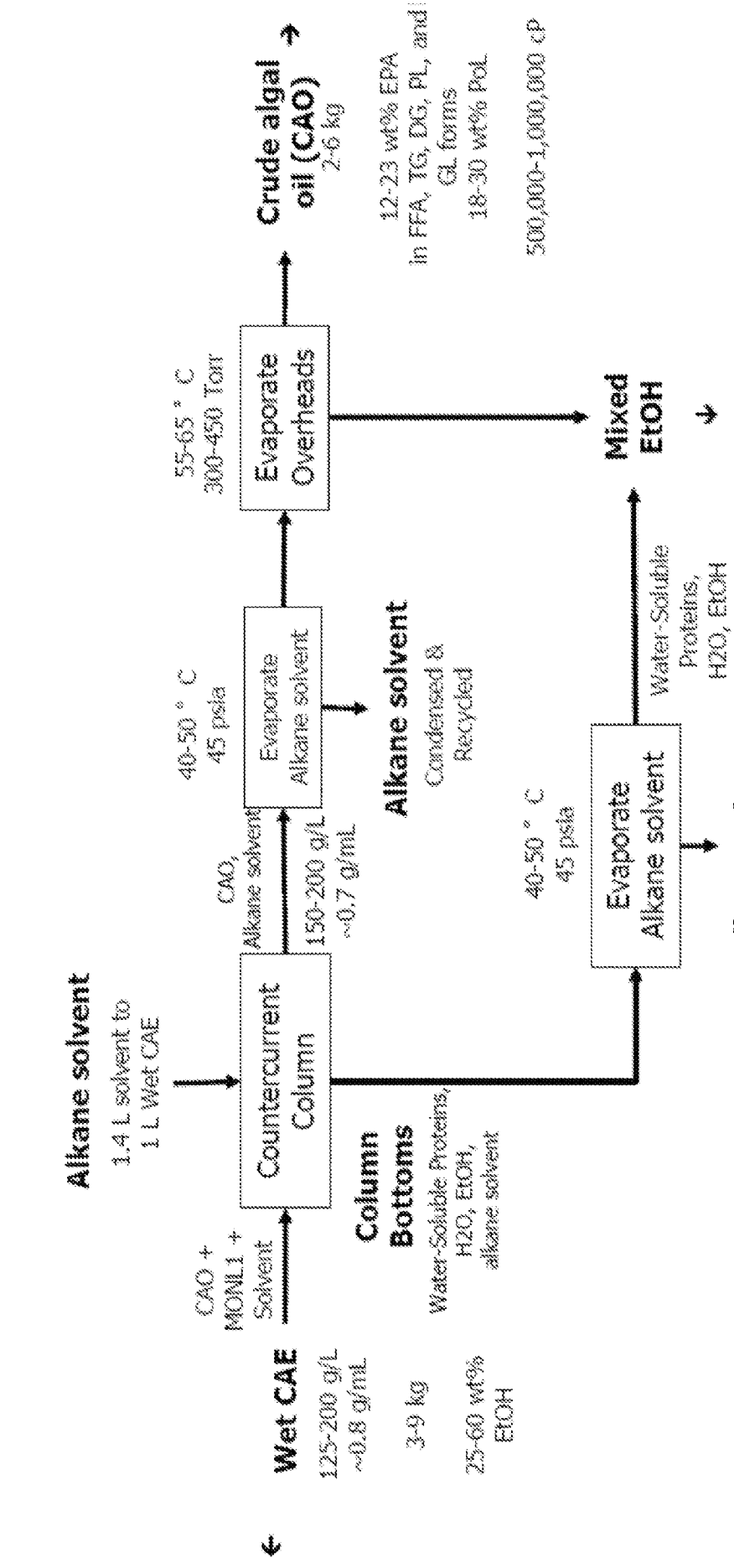

Alkane solvent
1.4 L solvent to 1 L Wet CAE
Countercurrent Column
CAO + MONL1 + Solvent
Wet CAE
125-200 g/L
~0.8 g/mL
3-9 kg
25-60 wt% EtOH
Column Bottoms
Water-Soluble Proteins, H2O, EtOH, alkane solvent
CAO, Alkane solvent
150-200 g/L
~0.7 g/mL
40-50 ° C
45 psia
Evaporate Alkane solvent
Alkane solvent
Condensed & Recycled
55-65 ° C
300-450 Torr
Evaporate Overheads
Crude algal oil (CAO)
2-6 kg
12-23 wt% EPA in FFA, TG, DG, PL, and GL forms
18-30 wt% PoL
300,000-1,000,000 cP
40-50 ° C
45 psia
Evaporate Alkane solvent
Water-Soluble Proteins, H2O, EtOH
Mixed EtOH
Alkane Solvent
Condensed & Recycled

*Fig. 8*

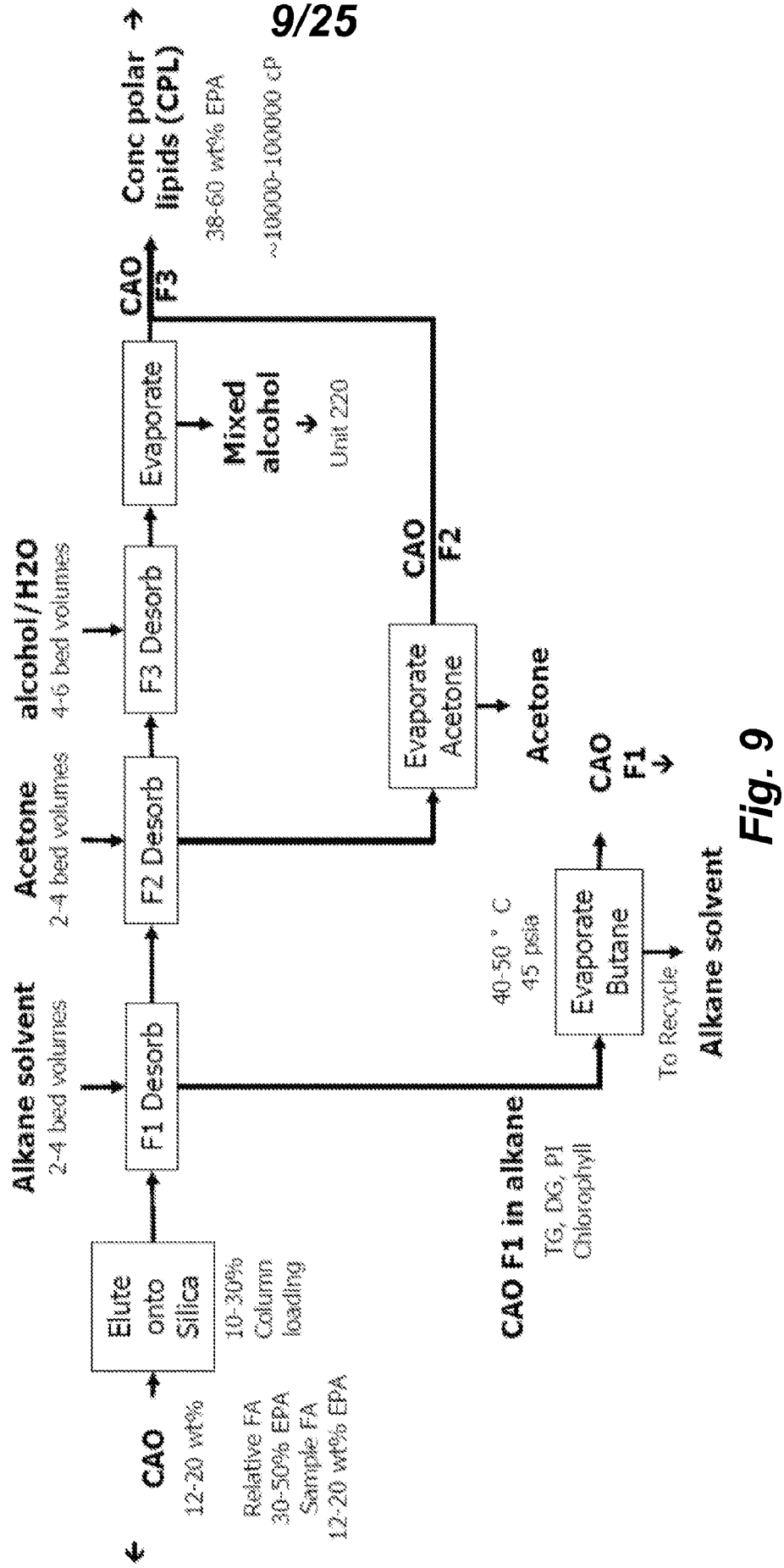

CAO
12-20 wt%
Relative FA
30-50% EPA
Sample FA
12-20 wt% EPA
Elute onto Silica
10-30% Column loading
Alkane solvent
2-4 bed volumes
F1 Desorb
Acetone
2-4 bed volumes
F2 Desorb
alcohol/H2O
4-6 bed volumes
F3 Desorb
Evaporate
Mixed alcohol
Unit 220
CAO F3
Conc polar lipids (CPL)
38-60 wt% EPA
~10000-100000 cP
CAO F2
Evaporate Acetone
Acetone
CAO F1 in alkane
TG, DG, P1
Chlorophyll
40-50 ° C
45 psia
Evaporate Butane
CAO F1
To Recycle
Alkane solvent

Fig. 9

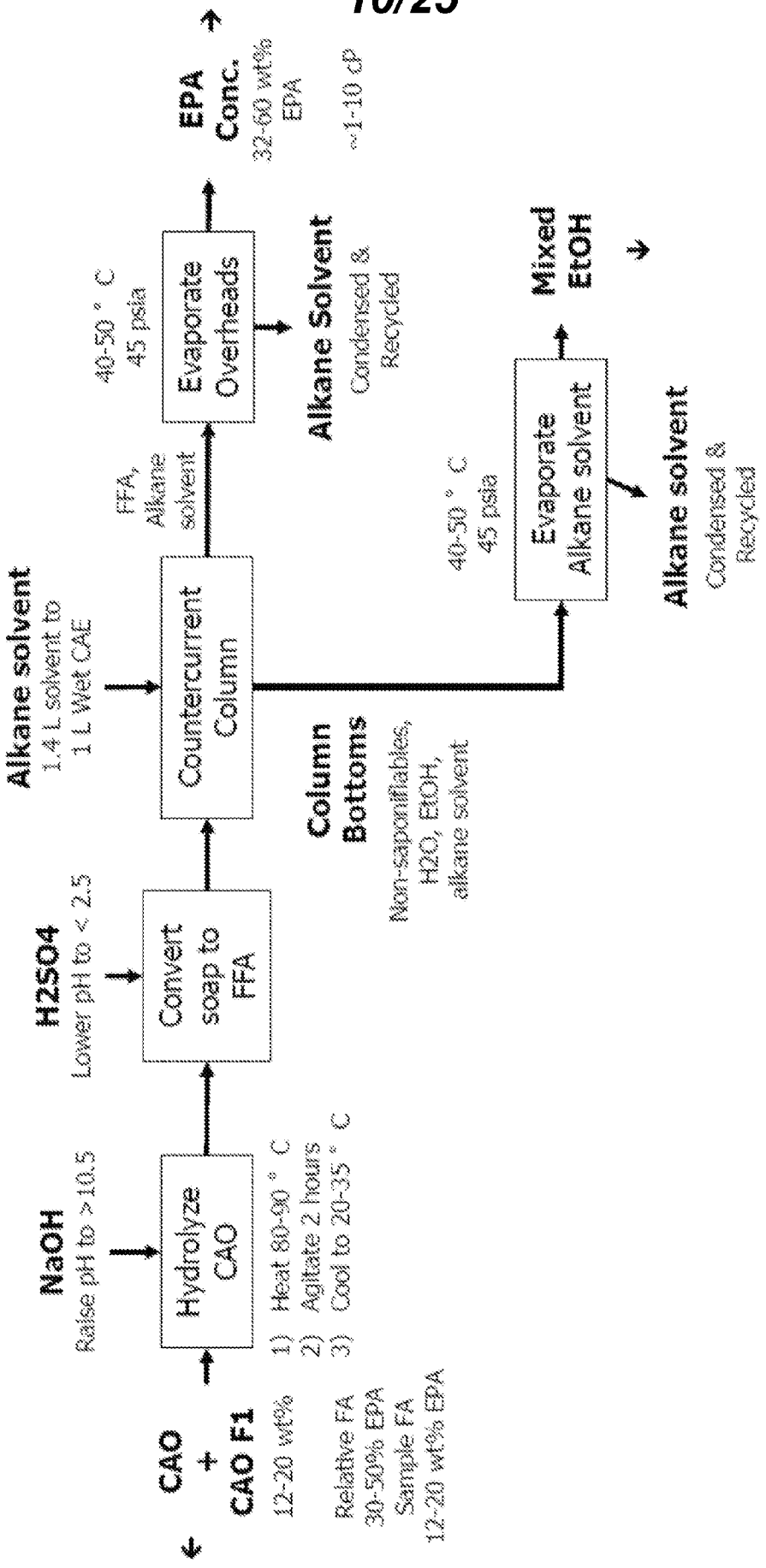

CAO
+
CAO F1
12-20 wt%
Relative FA
30-50% EPA
Sample FA
12-20 wt% EPA
NaOH
Raise pH to >10.5
Hydrolyze CAO
1) Heat 80-90 ° C
2) Agitate 2 hours
3) Cool to 20-35 ° C
H2SO4
Lower pH to < 2.5
Convert soap to FFA
Alkane solvent
1.4 L solvent to 1 L Wet CAE
Countercurrent Column
FFA, Alkane solvent
40-50 ° C
45 psia
Evaporate Overheads
EPA Conc.
32-60 wt% EPA
~1-10 cP
Alkane Solvent
Condensed & Recycled
Column Bottoms
Non-saponifiables, H2O, EtOH, alkane solvent
40-50 ° C
45 psia
Evaporate Alkane solvent
Mixed EtOH
Alkane solvent
Condensed & Recycled

*Fig. 10*

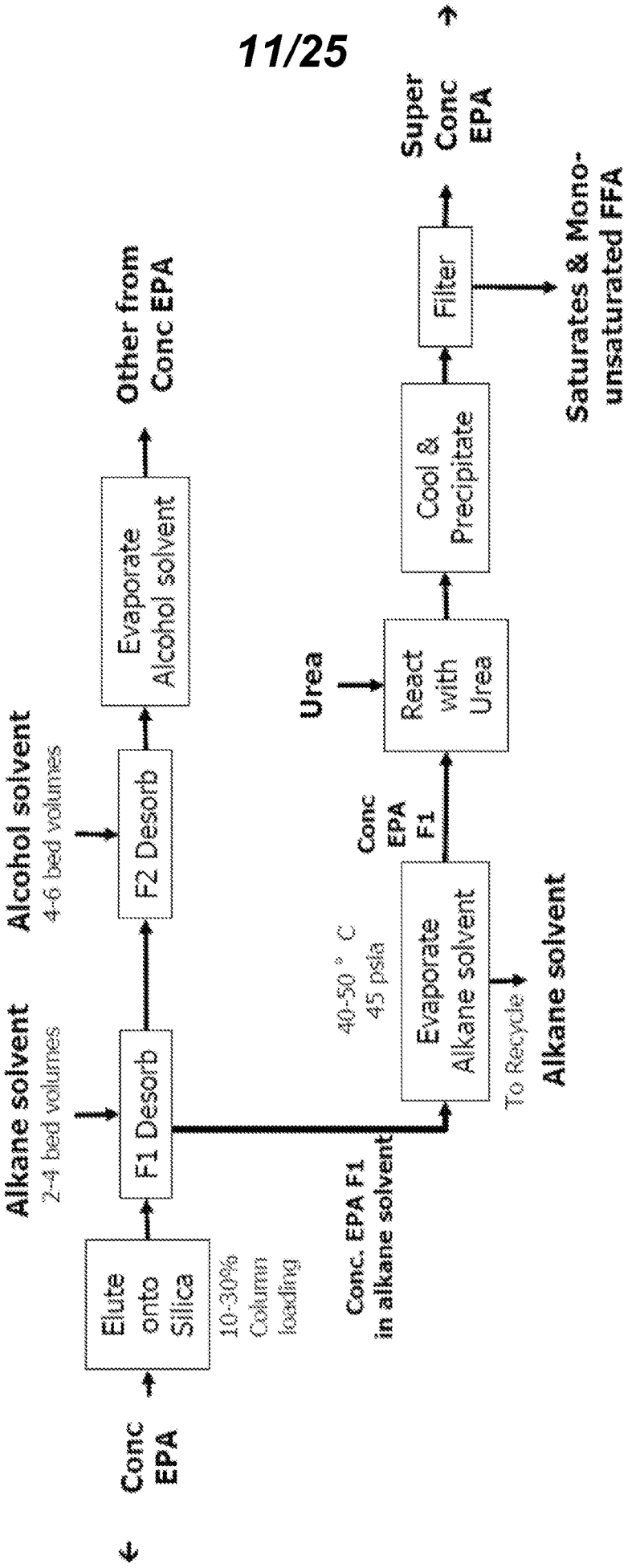

Conc EPA
Elute onto Silica
10-30% Column loading
Alkane solvent
2-4 bed volumes
F1 Desorb
Alcohol solvent
4-6 bed volumes
F2 Desorb
Evaporate Alcohol solvent
Other from Conc EPA
Conc. EPA F1 in alkane solvent
40-50 ° C
45 psia
Evaporate Alkane solvent
To Recycle
Alkane solvent
Conc EPA F1
Urea
React with Urea
Cool & Precipitate
Filter
Saturates & Mono-unsaturated FFA
Super Conc EPA

*Fig. 11*

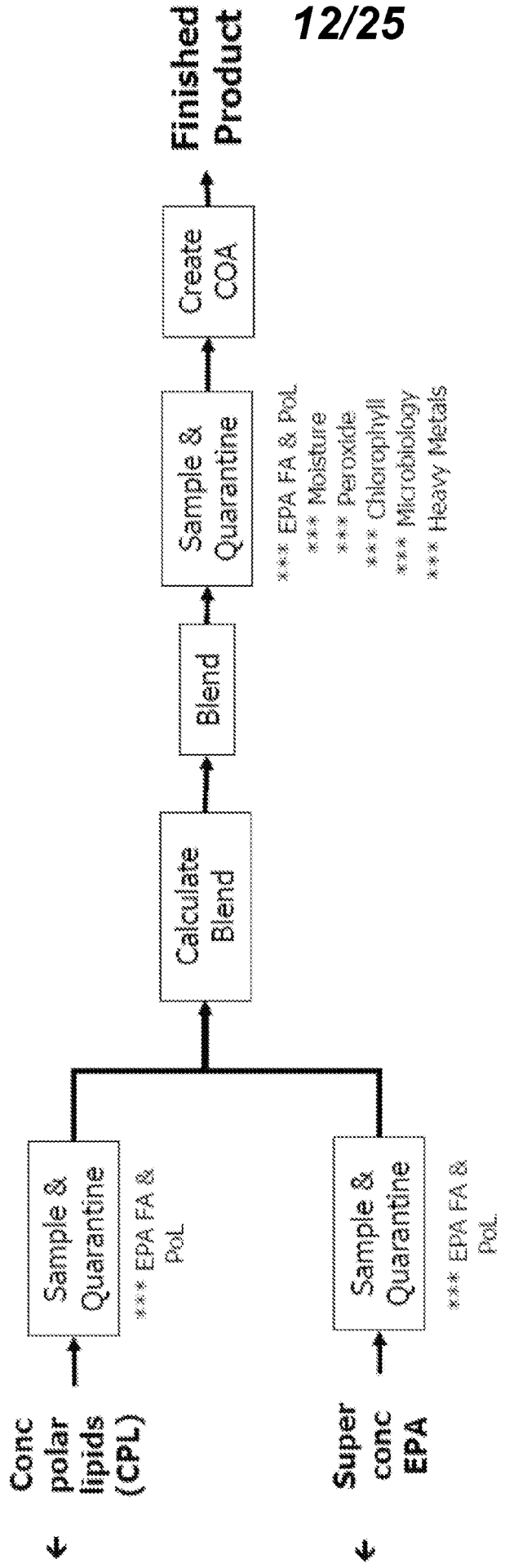

Conc polar lipids (CPL)
Super conc EPA
Sample & Quarantine
*** EPA FA & PoL
Sample & Quarantine
*** EPA FA & PoL
Calculate Blend
Blend
Sample & Quarantine
*** EPA FA & PoL
*** Moisture
*** Peroxide
*** Chlorophyll
*** Microbiology
*** Heavy Metals
Create COA
Finished Product

Fig. 12

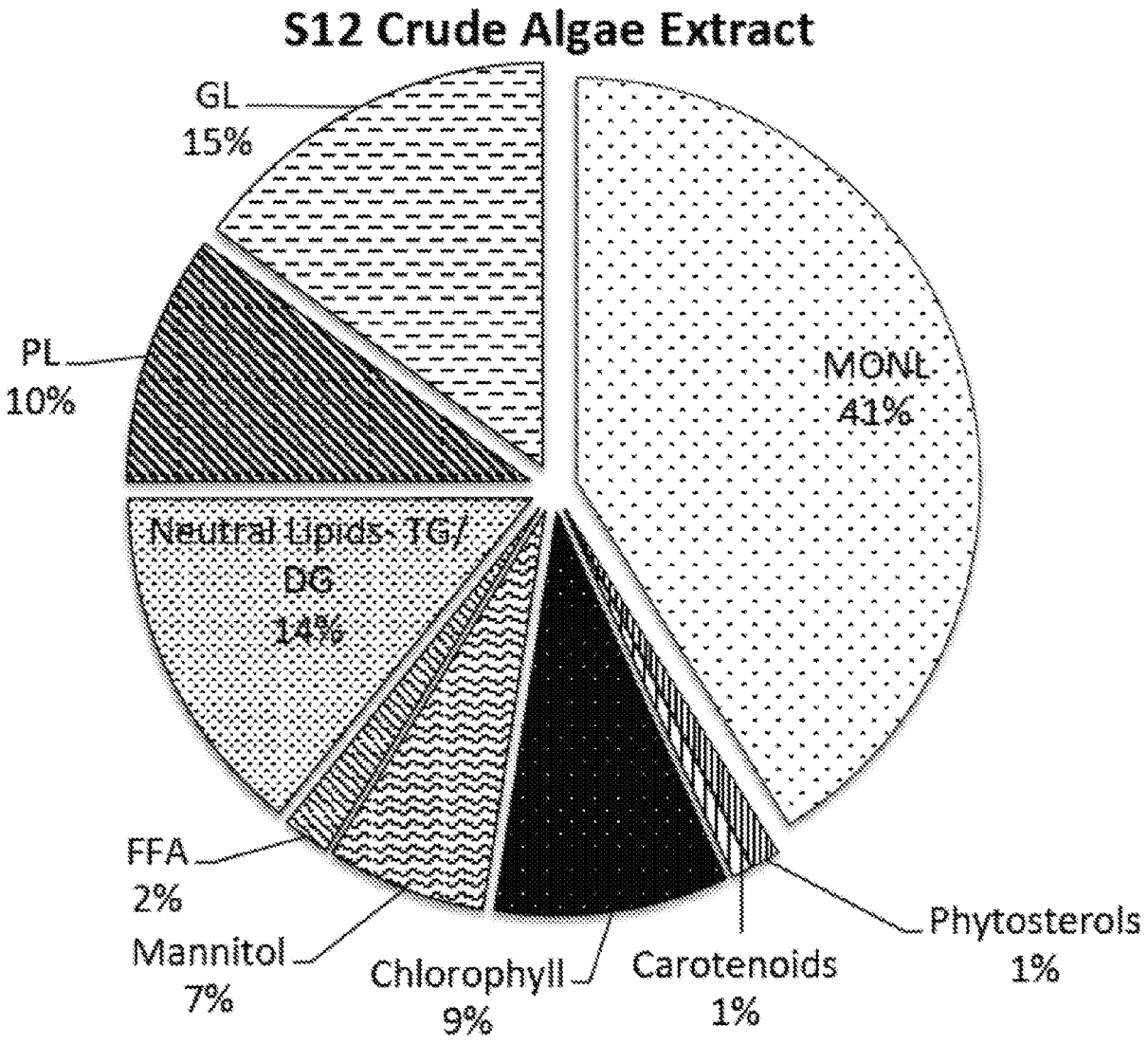

S12 Crude Algae Extract
GL
15%
PL
10%
MONL
41%
Neutral Lipids- TG/
DG
14%
FFA
2%
Mannitol
7%
Chlorophyll
9%
Carotenoids
1%
Phytosterols
1%

Fig. 13

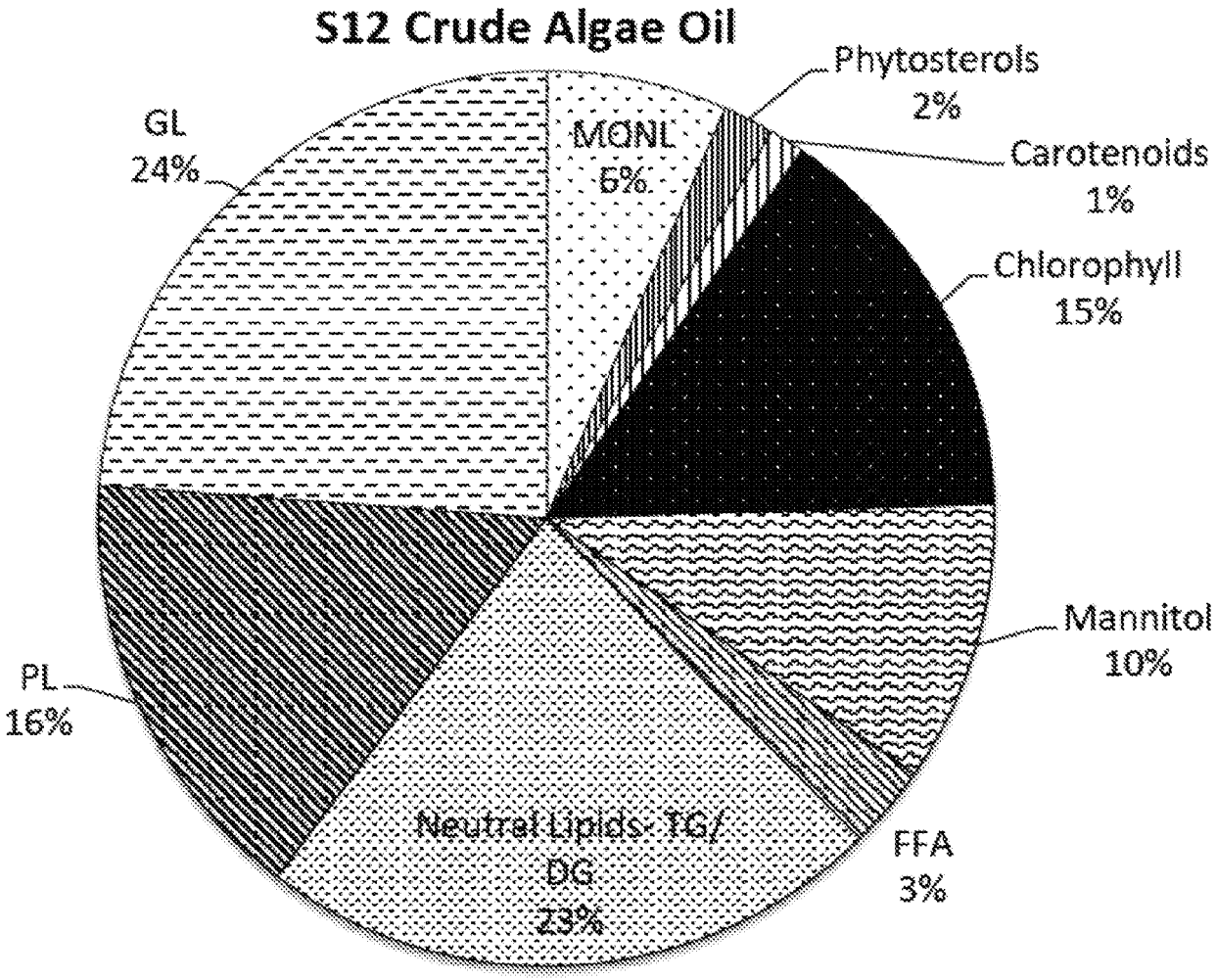

S12 Crude Algae Oil
Phytosterols 2%
Carotenoids 1%
Chlorophyll 15%
Mannitol 10%
FFA 3%
Neutral Lipids- TG/ DG 23%
PL 16%
GL 24%
MGNL 6%

Fig. 14

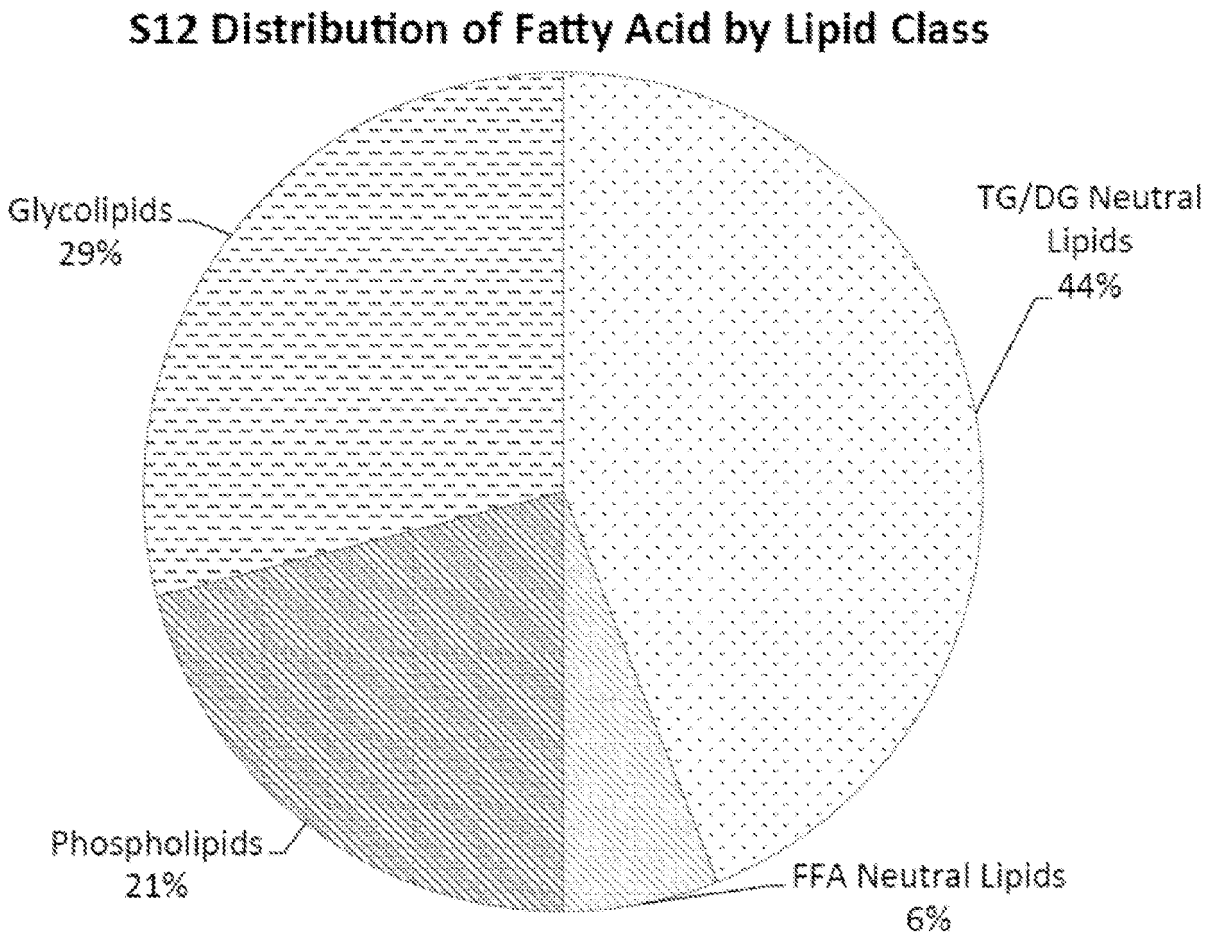

S12 Distribution of Fatty Acid by Lipid Class
Glycolipids
29%
TG/DG Neutral
Lipids
44%
Phospholipids
21%
FFA Neutral Lipids
6%

Fig. 15

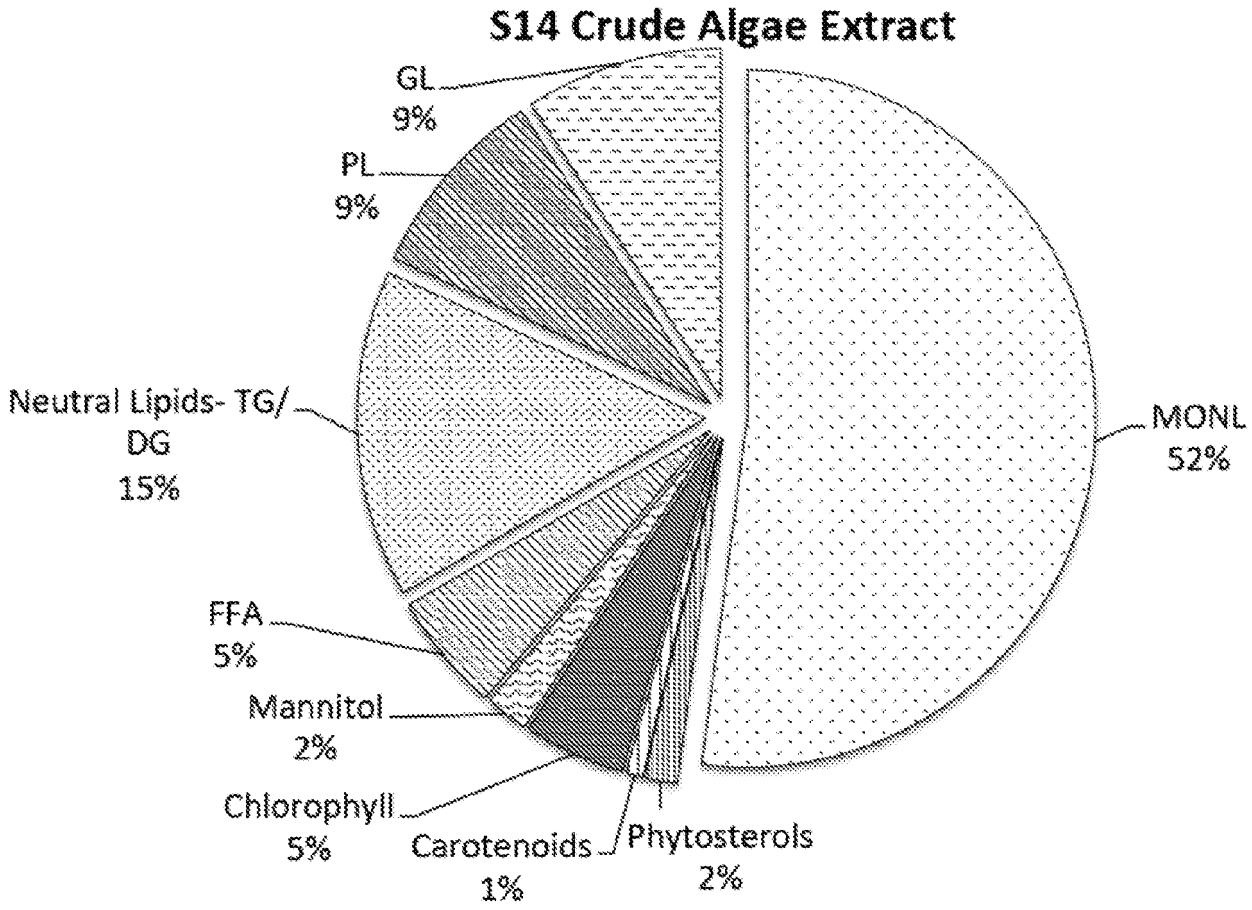

S14 Crude Algae Extract
GL
9%
PL
9%
Neutral Lipids- TG/
DG
15%
FFA
5%
Mannitol
2%
Chlorophyll
5%
Carotenoids
1%
Phytosterols
2%
MONL
52%

Fig. 16

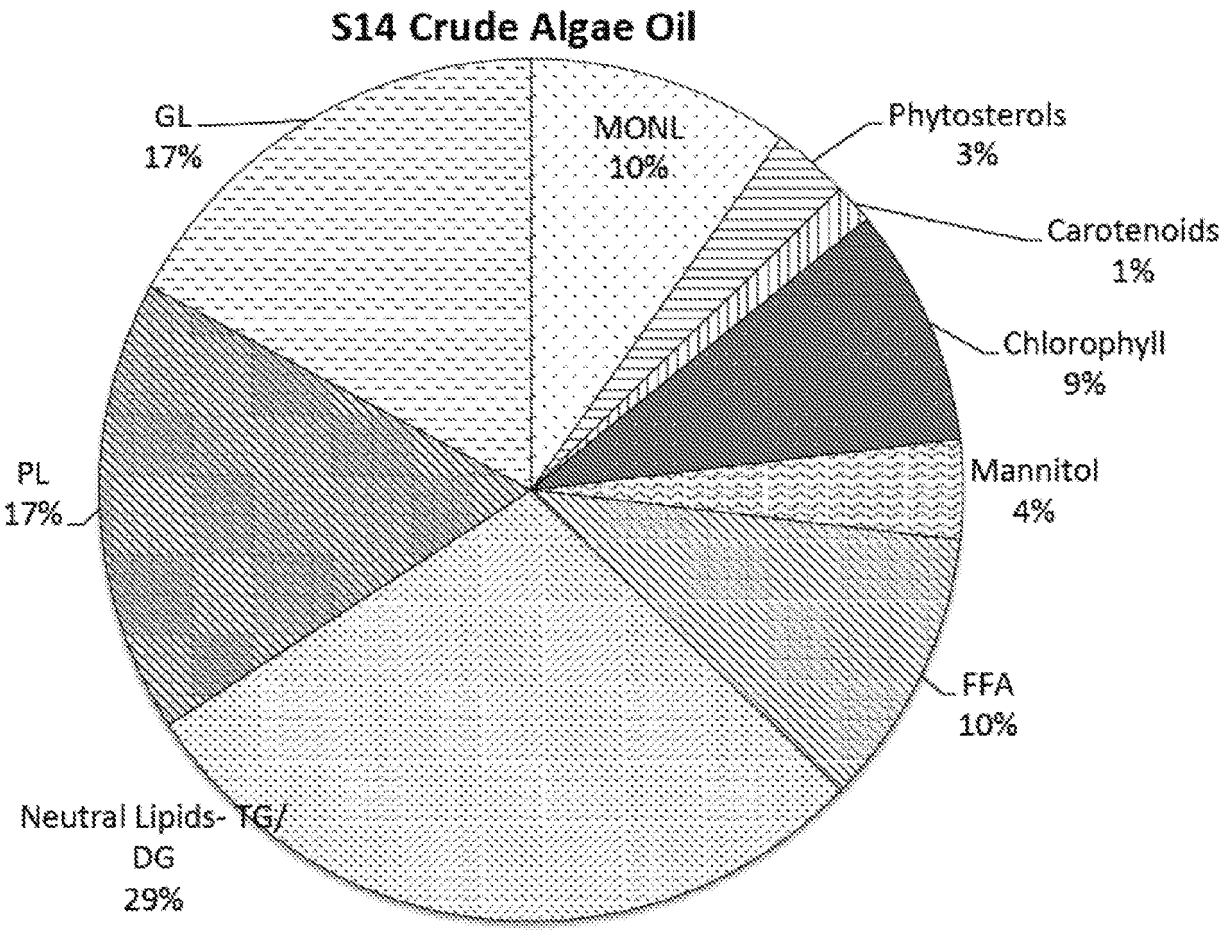

S14 Crude Algae Oil
MONL
10%
Phytosterols
3%
Carotenoids
1%
Chlorophyll
9%
Mannitol
4%
FFA
10%
Neutral Lipids- TG/
DG
29%
PL
17%
GL
17%

Fig. 17

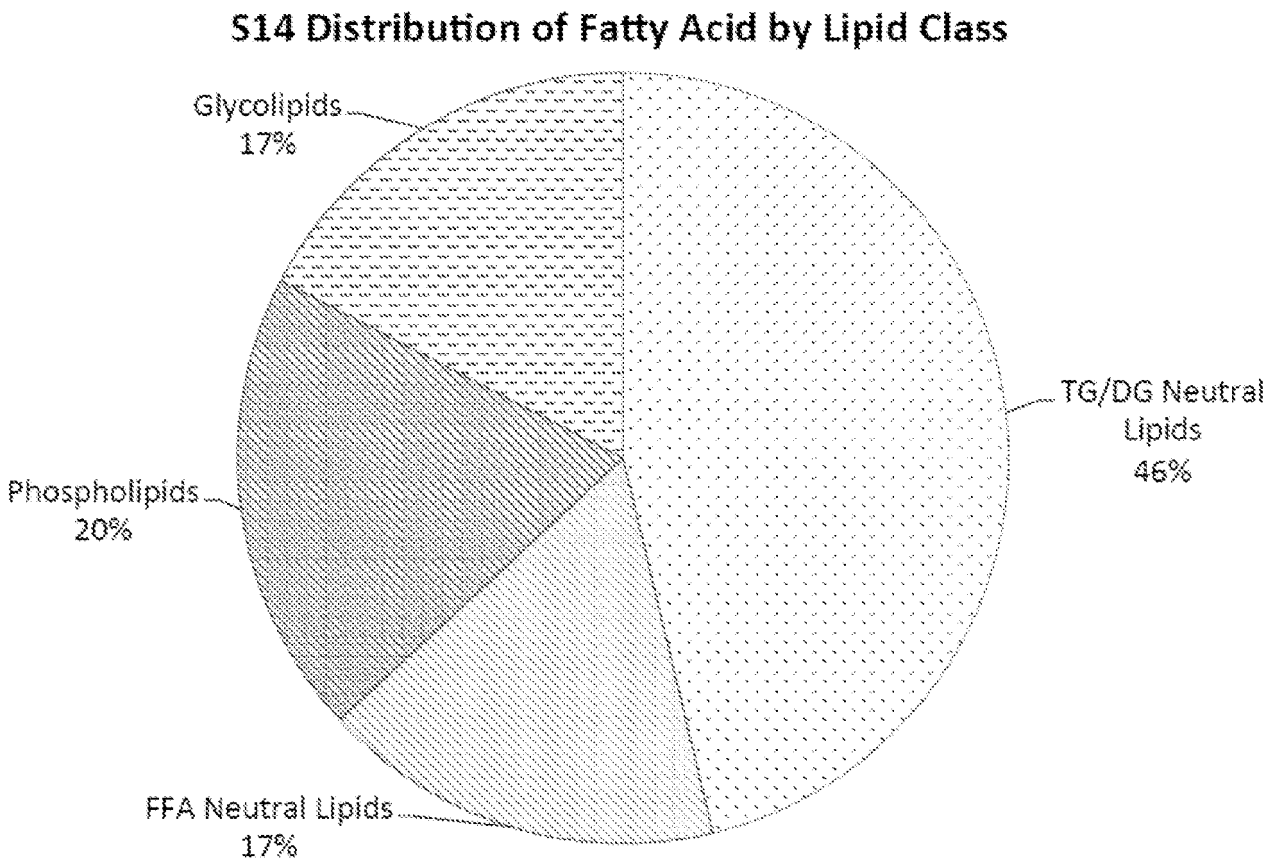

S14 Distribution of Fatty Acid by Lipid Class
Glycolipids
17%
TG/DG Neutral
Lipids
46%
Phospholipids
20%
FFA Neutral Lipids
17%

Fig. 18

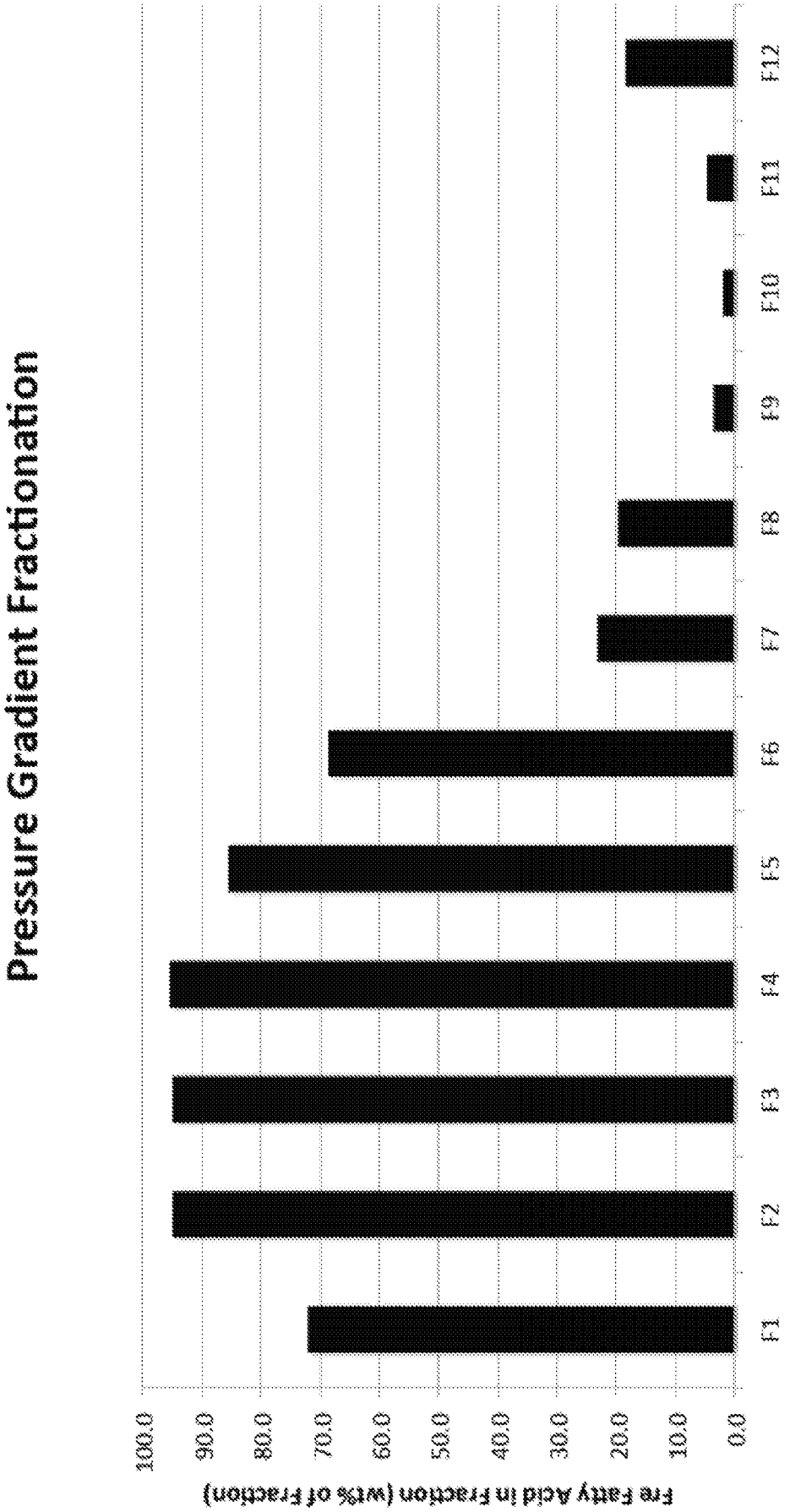

Pressure Gradient Fractionation
Fre Fatty Acid in Fraction (wt% of Fraction)
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12
Fraction Number

*Fig. 19*

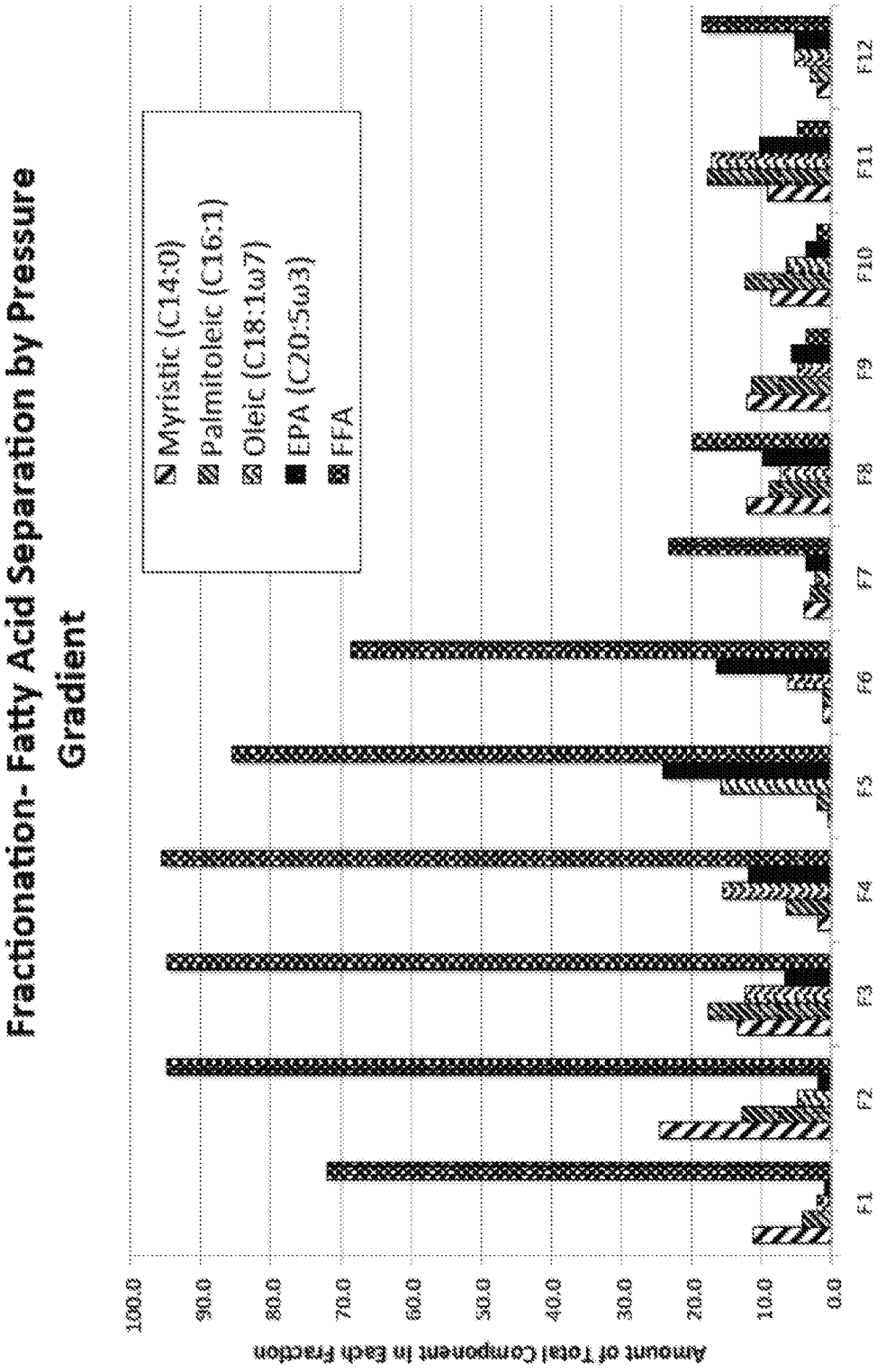

Fractionation- Fatty Acid Separation by Pressure Gradient
Myristic (C14:0)
Palmitoleic (C16:1)
Oleic (C18:1ω7)
EPA (C20:5ω3)
FFA
Amount of Total Component in Each Fraction
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
F1
F2
F3
F4
F5
F6
F7
F8
F9
F10
F11
F12

Fig. 20

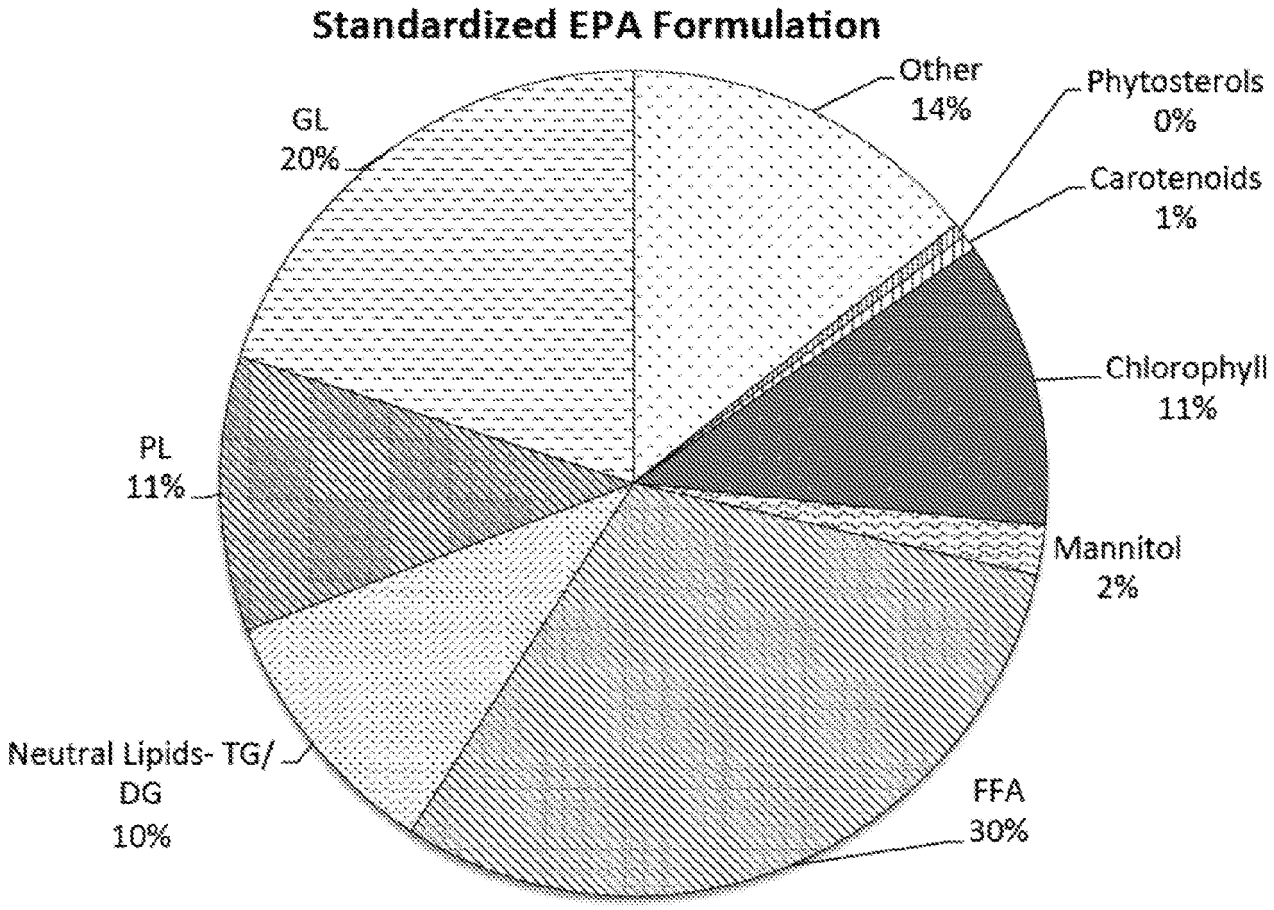

Standardized EPA Formulation
Other
14%
Phytosterols
0%
Carotenoids
1%
Chlorophyll
11%
Mannitol
2%
FFA
30%
Neutral Lipids- TG/
DG
10%
PL
11%
GL
20%

Fig. 21

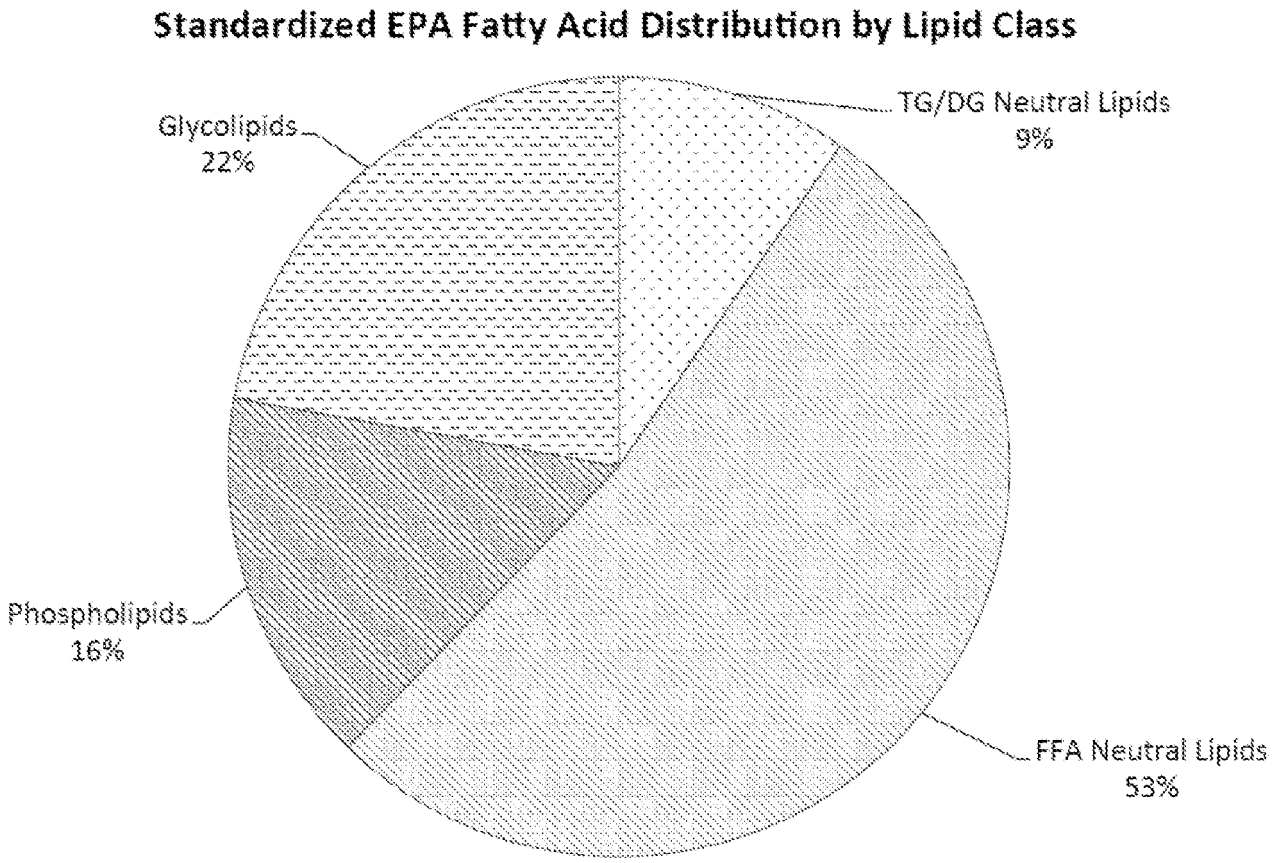

Standardized EPA Fatty Acid Distribution by Lipid Class
TG/DG Neutral Lipids
9%
Glycolipids
22%
Phospholipids
16%
FFA Neutral Lipids
53%

Fig. 22

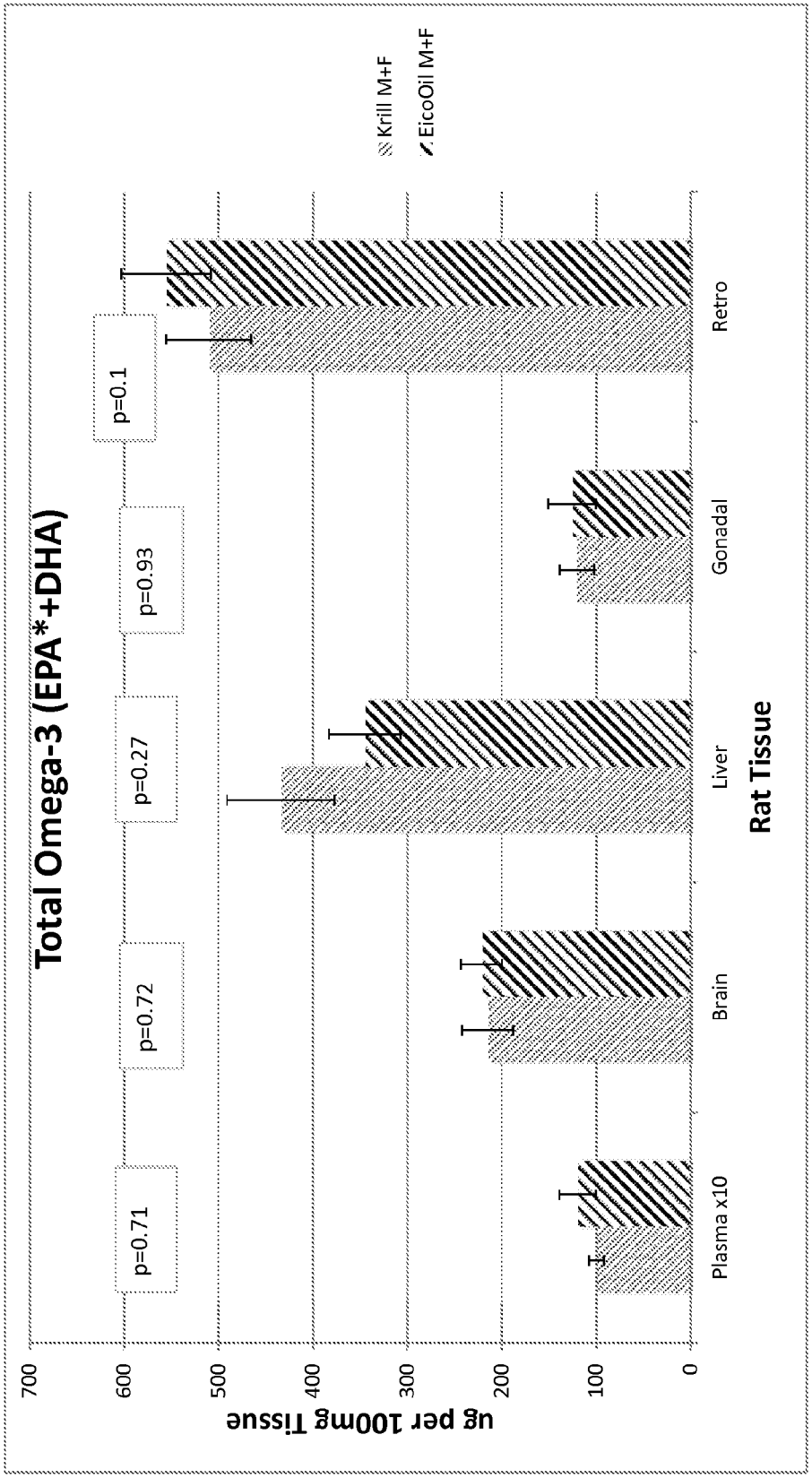

Total Omega-3 (EPA*+DHA)
Krill M+F
EicoOil M+F
p=0.71
p=0.72
p=0.27
p=0.93
p=0.1
ug per 100mg Tissue
0
100
200
300
400
500
600
700
Plasma x10
Brain
Liver
Gonadal
Retro
Rat Tissue

*Fig. 23*

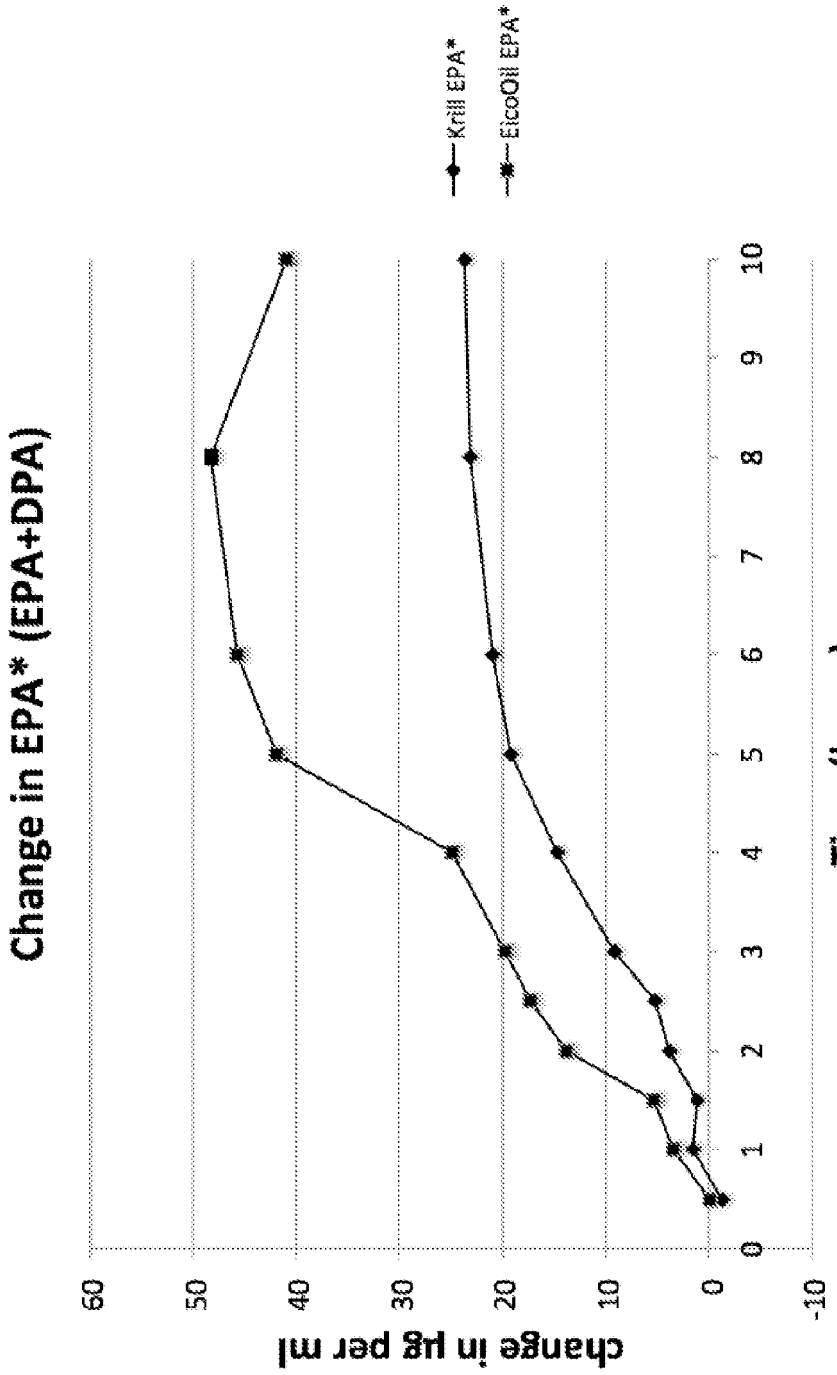

Change in EPA* (EPA+DPA)
Krill EPA*
EicoOil EPA*
change in µg per ml
60
50
40
30
20
10
0
-10
0
1
2
3
4
5
6
7
8
9
10
Time (hours)

Fig. 24

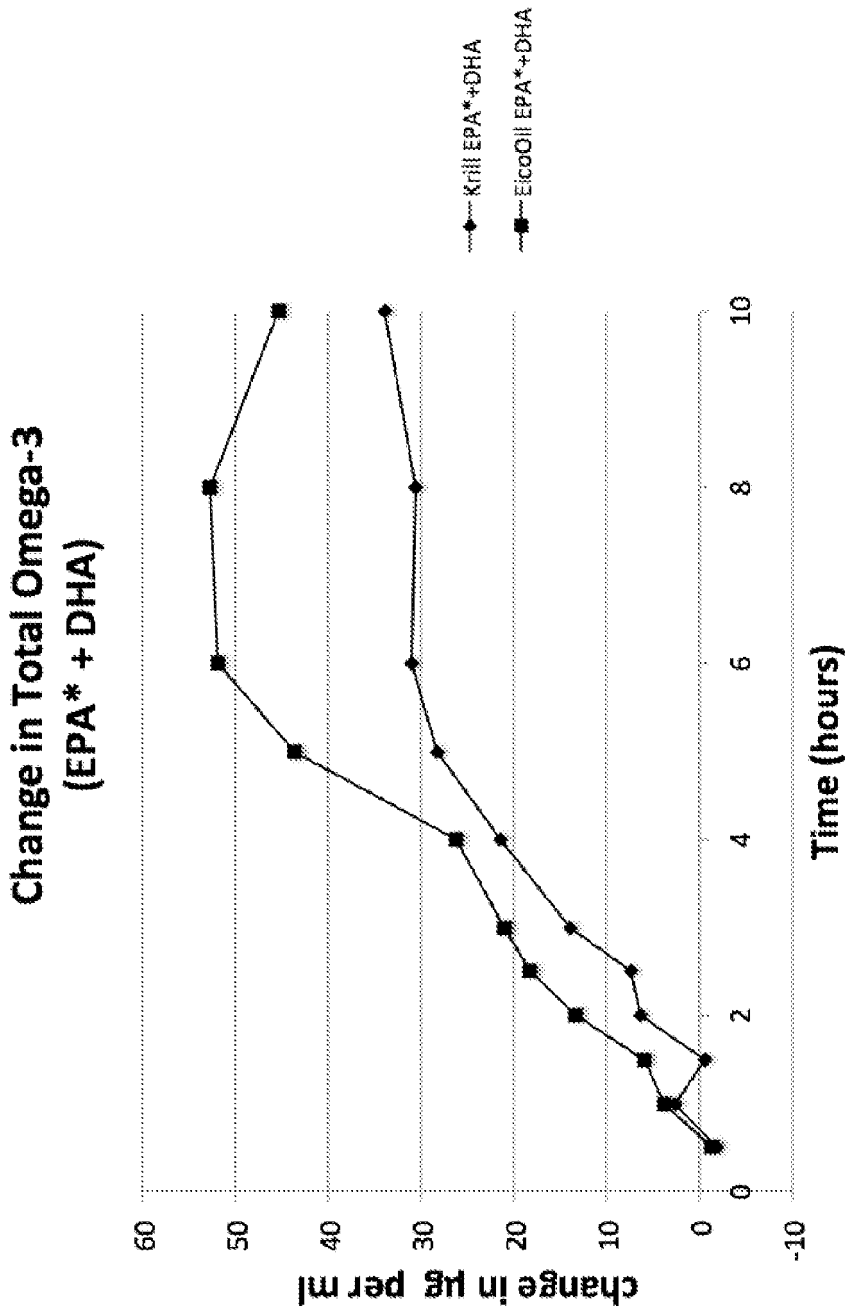

Change in Total Omega-3
(EPA* + DHA)
Krill EPA*+DHA
EicoOil EPA*+DHA
change in µg per ml
60
50
40
30
20
10
0
-10
0
2
4
6
8
10
Time (hours)

Fig. 25