FIG. 1

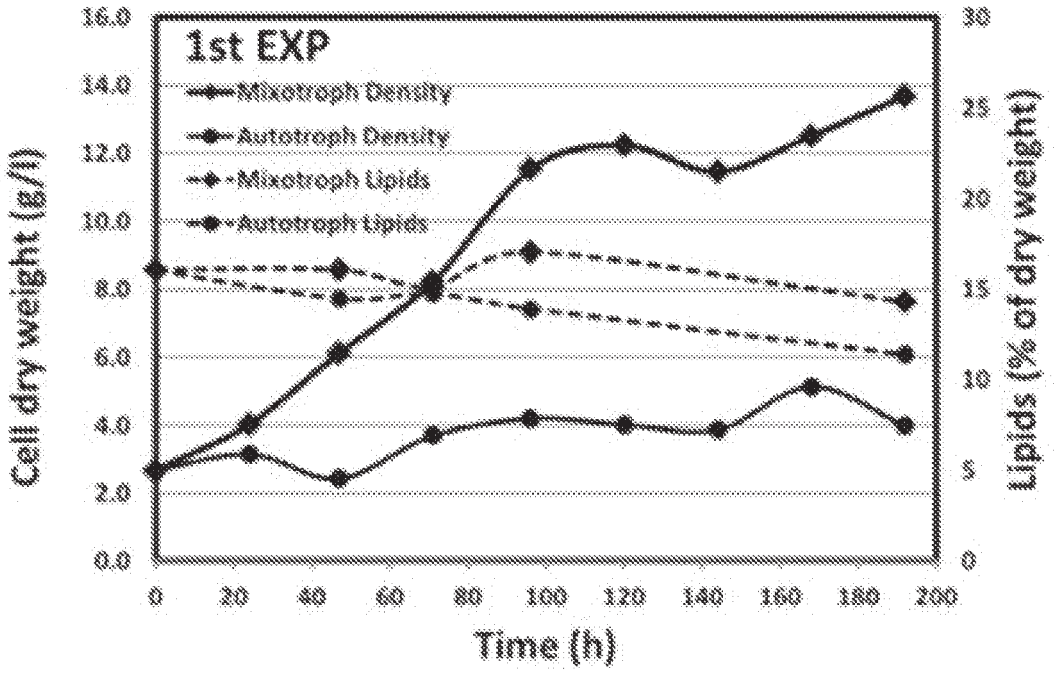

1st EXP
Mixotroph Density
Autotroph Density
Mixotroph Lipids
Autotroph Lipids
Cell dry weight (g/l)
Lipids (% of dry weight)
Time (h)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180
200

FIG. 2

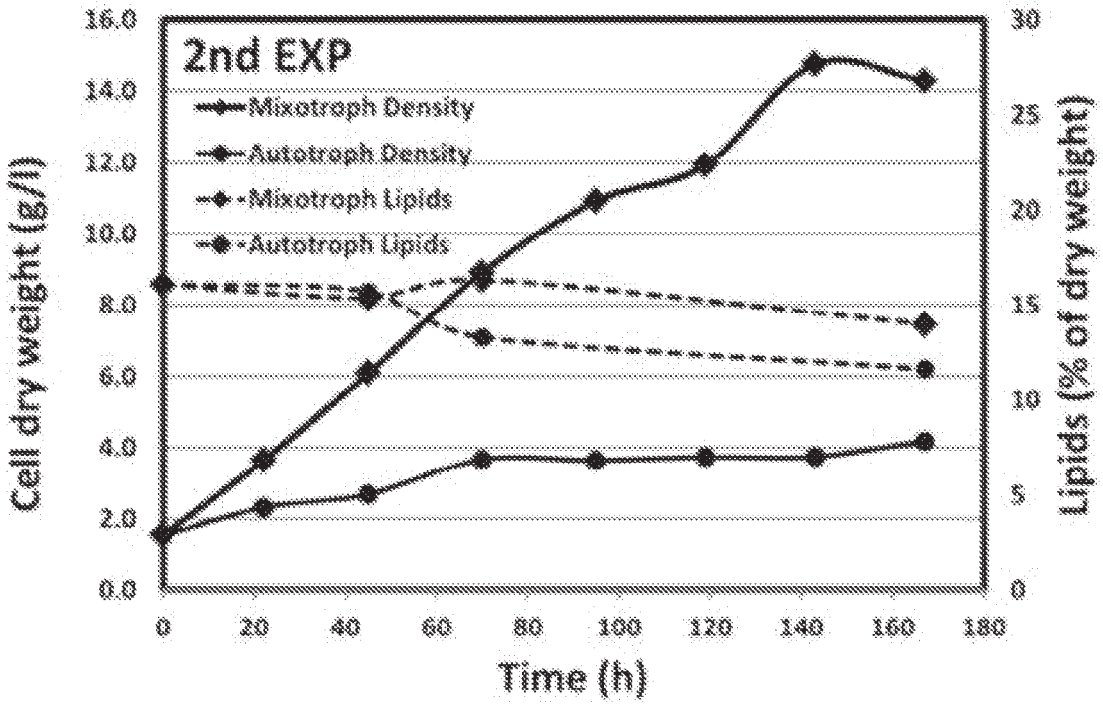

2nd EXP
Mixotroph Density
Autotroph Density
Mixotroph Lipids
Autotroph Lipids
Cell dry weight (g/l)
Lipids (% of dry weight)
Time (h)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
160
180

FIG. 3

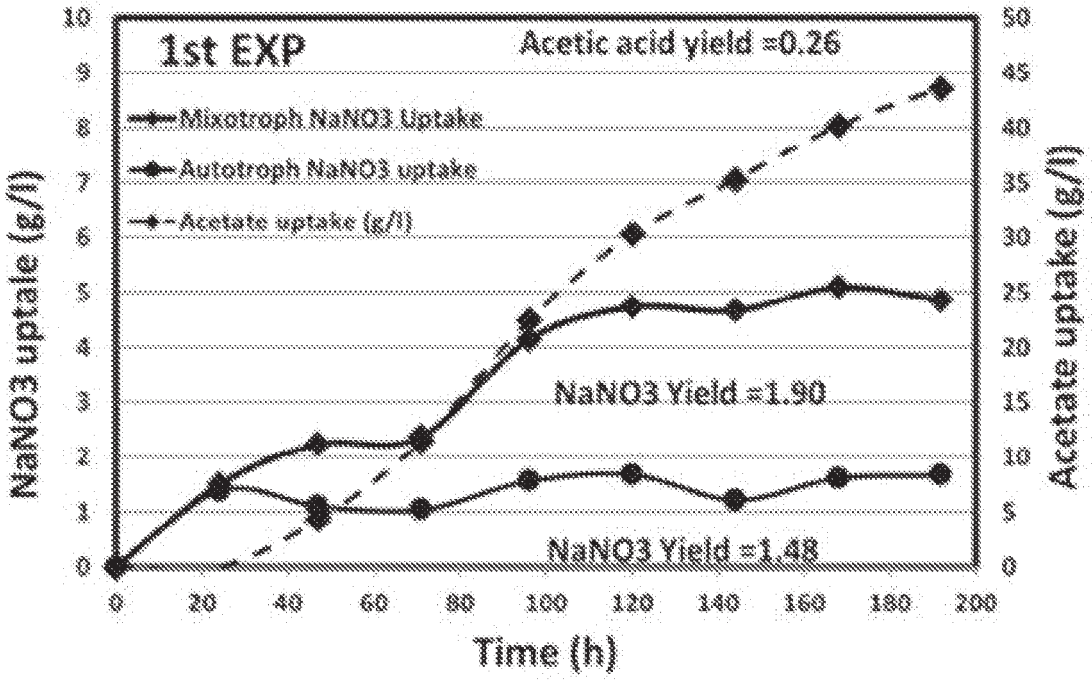

1st EXP
Acetic acid yield =0.26
Mixotroph NaNO3 Uptake
Autotroph NaNO3 uptake
Acetate uptake (g/l)
NaNO3 Yield =1.90
NaNO3 Yield =1.48
NaNO3 uptale (g/l)
Acetate uptake (g/l)
Time (h)
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
45
50
0
20
40
60
80
100
120
140
160
180
200

FIG. 4

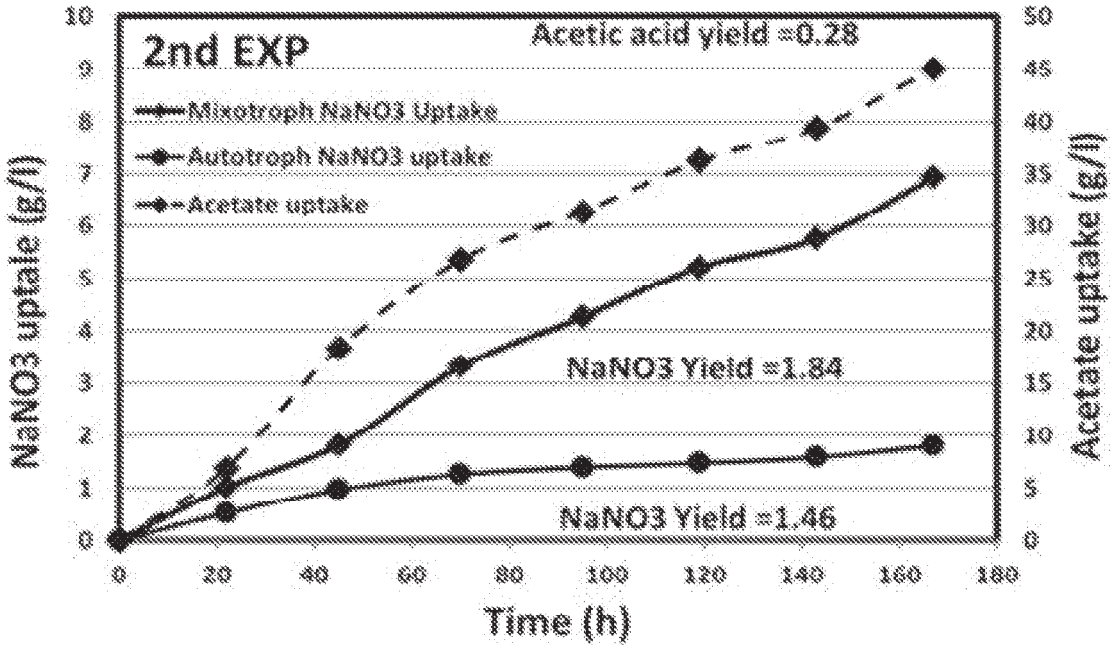

2nd EXP
Acetic acid yield =0.28
Mixotroph NaNO3 Uptake
Autotroph NaNO3 uptake
Acetate uptake
NaNO3 Yield =1.84
NaNO3 Yield =1.46
NaNO3 uptale (g/l)
Acetate uptake (g/l)
Time (h)
0
20
40
60
80
100
120
140
160
180
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
45
50

FIG. 5

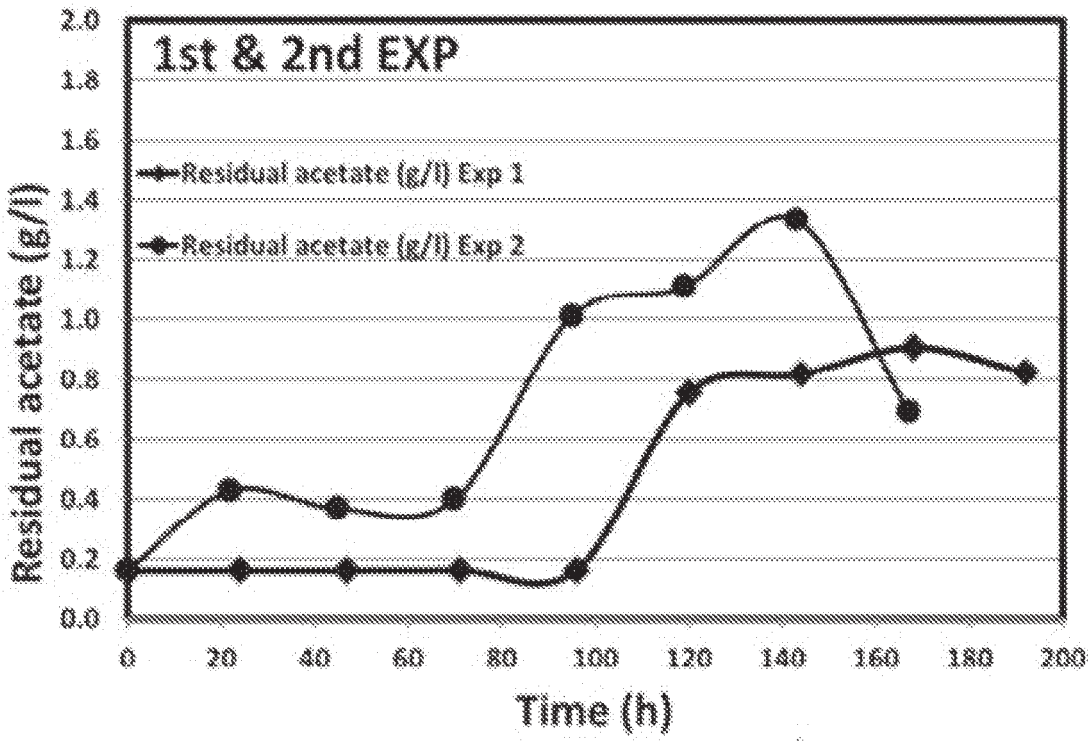

1st & 2nd EXP
Residual acetate (g/l) Exp 1
Residual acetate (g/l) Exp 2
Residual acetate (g/l)
Time (h)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
140
160
180
200

FIG. 6

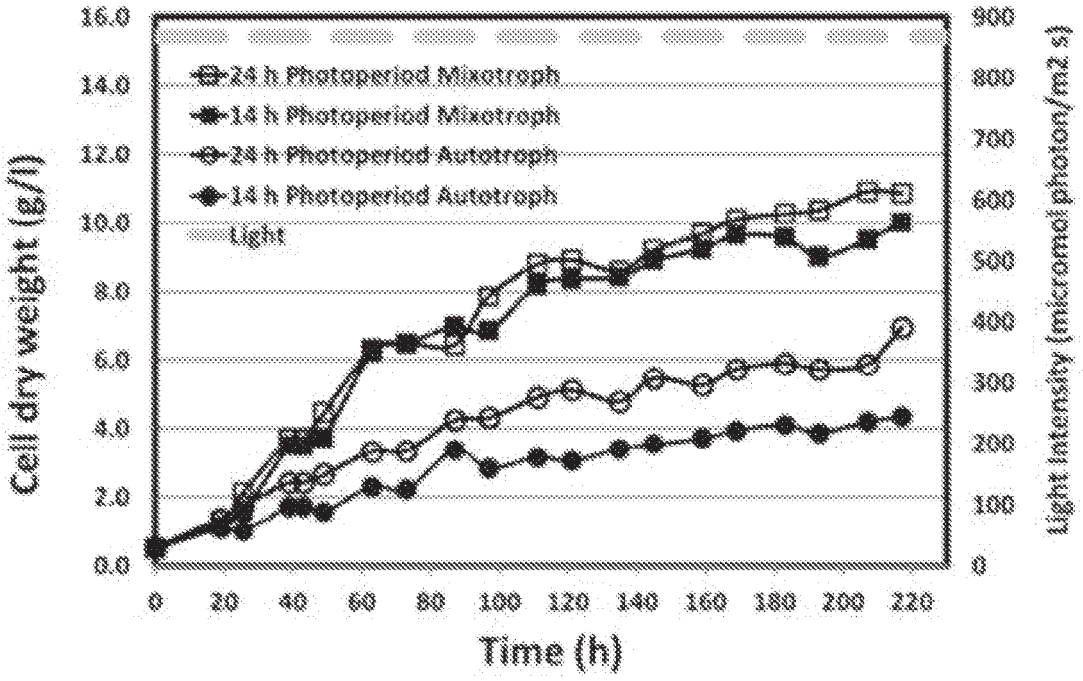

24 h Photoperiod Mixotroph
14 h Photoperiod Mixotroph
24 h Photoperiod Autotroph
14 h Photoperiod Autotroph
Light
Cell dry weight (g/l)
Light Intensity (micromol photon/m2 s)
Time (h)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
900
800
700
600
500
400
300
200
100
0
0
20
40
60
80
100
120
140
160
180
200
220

FIG. 7

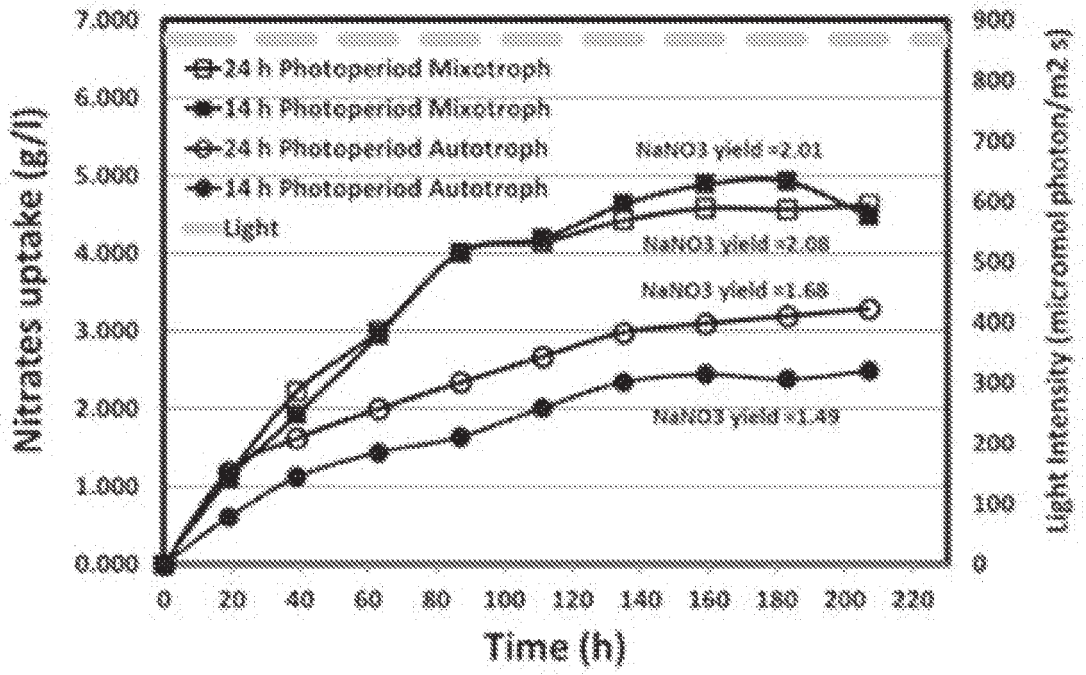

Nitrates uptake (g/l)
Light Intensity (micromol photon/m2 s)
Time (h)
24 h Photoperiod Mixotroph
14 h Photoperiod Mixotroph
24 h Photoperiod Autotroph
14 h Photoperiod Autotroph
Light
NaNO3 yield =2.01
NaNO3 yield =2.08
NaNO3 yield =1.68
NaNO3 yield =1.48
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
900
800
700
600
500
400
300
200
100
0
0
20
40
60
80
100
120
140
160
180
200
220

FIG. 8

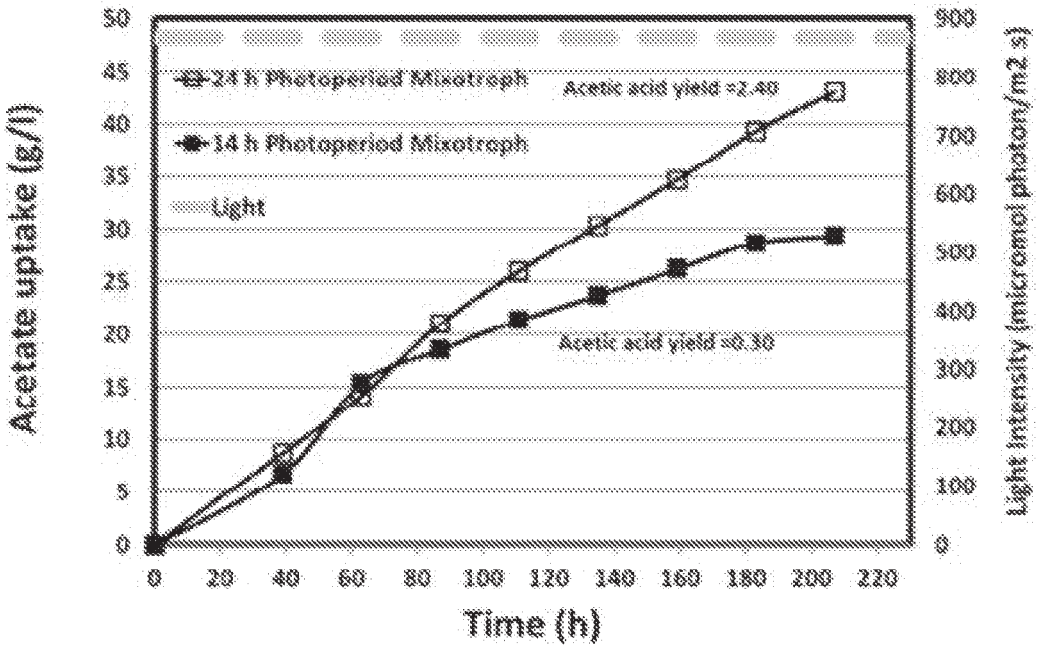

24 h Photoperiod Mixotroph
14 h Photoperiod Mixotroph
Light
Acetic acid yield =2.40
Acetic acid yield =0.30
Acetate uptake (g/l)
Light intensity (micromol photon/m2 s)
Time (h)
0
5
10
15
20
25
30
35
40
45
50
100
200
300
400
500
600
700
800
900
0
20
40
60
80
100
120
140
160
180
200
220

FIG. 9

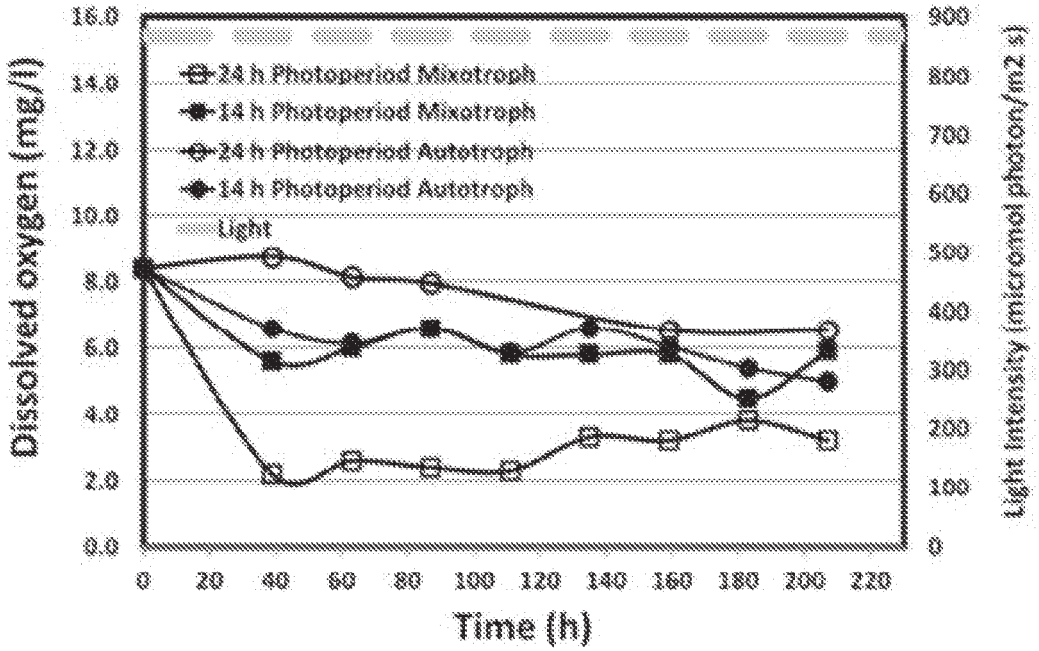

Dissolved oxygen (mg/l)
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
24 h Photoperiod Mixotroph
14 h Photoperiod Mixotroph
24 h Photoperiod Autotroph
14 h Photoperiod Autotroph
Light
0
20
40
60
80
100
120
140
160
180
200
220
Time (h)
900
800
700
600
500
400
300
200
100
0
Light Intensity (micromol photon/m2 s)

FIG. 10

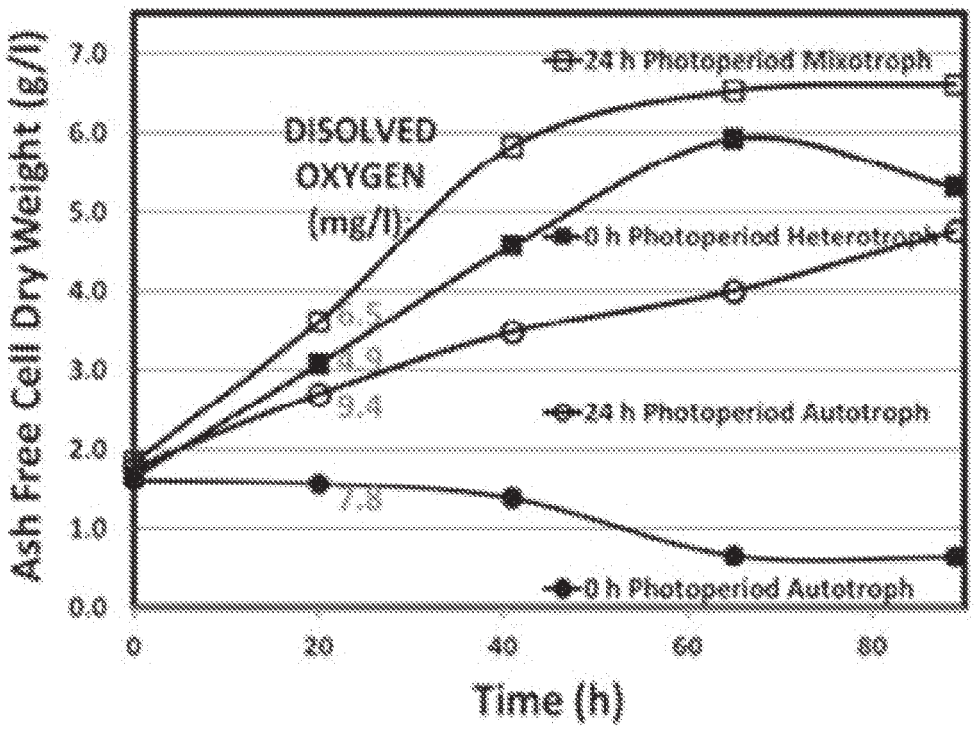

Ash Free Cell Dry Weight (g/l)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
20
40
60
80
Time (h)
24 h Photoperiod Mixotroph
DISOLVED OXYGEN (mg/l):
0 h Photoperiod Heterotroph
6.5
4.9
3.4
24 h Photoperiod Autotroph
7.8
0 h Photoperiod Autotroph

FIG. 11

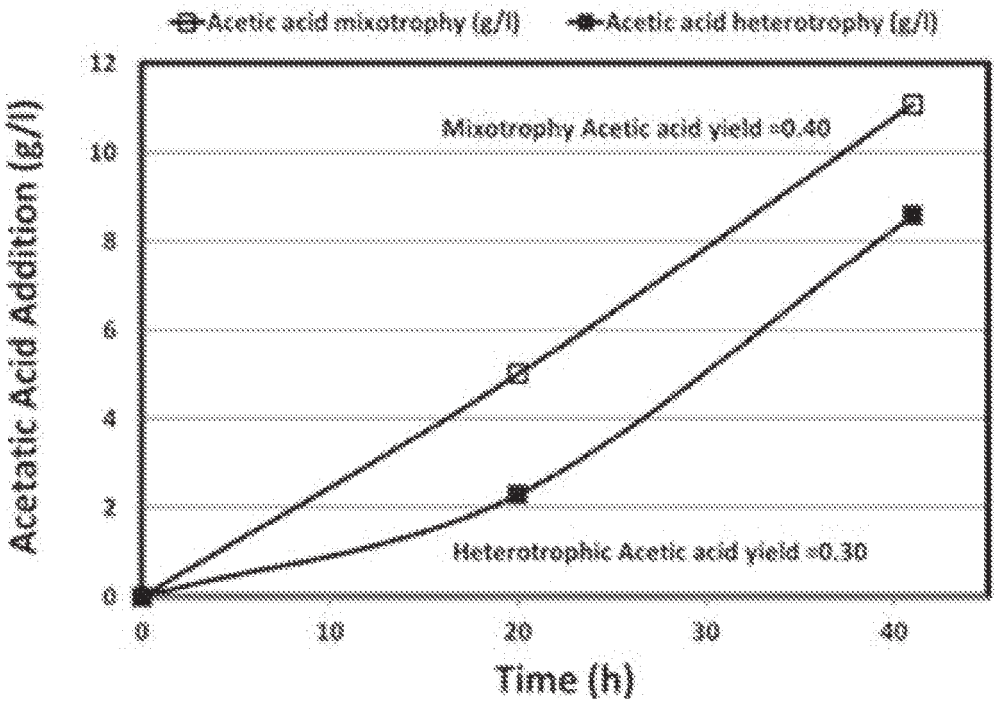

Acetic acid mixotrophy (g/l)
Acetic acid heterotrophy (g/l)
Acetatic Acid Addition (g/l)
Mixotrophy Acetic acid yield =0.40
Heterotrophic Acetic acid yield =0.30
0
2
4
6
8
10
12
0
10
20
30
40
Time (h)

FIG. 12

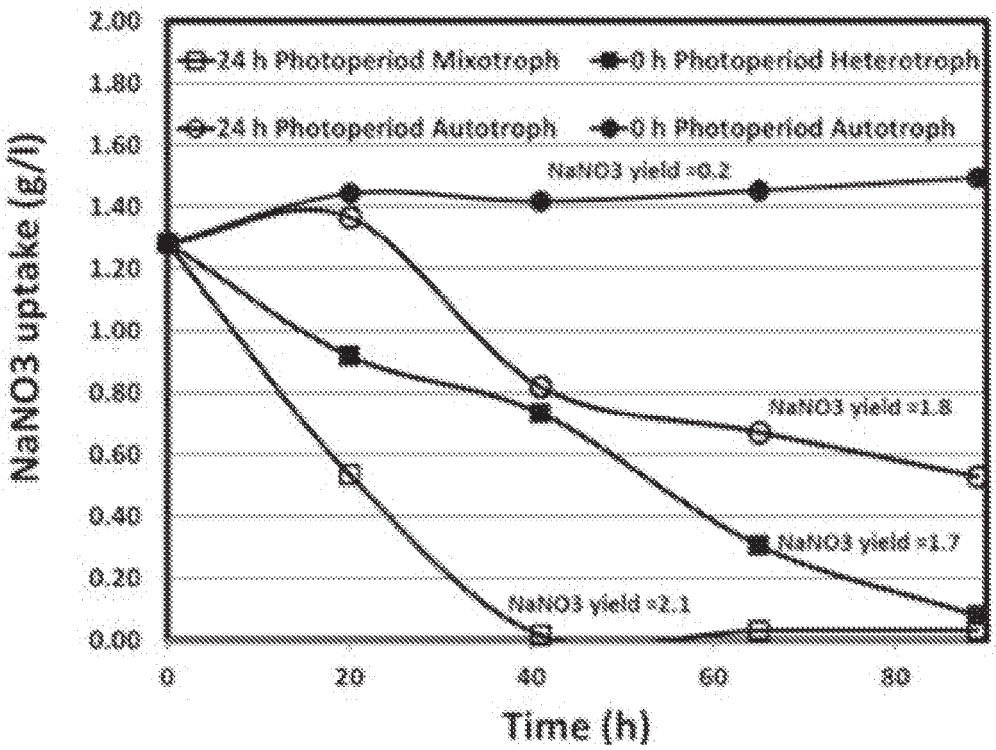

2.00
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
NaNO3 uptake (g/l)
24 h Photoperiod Mixotroph
0 h Photoperiod Heterotroph
24 h Photoperiod Autotroph
0 h Photoperiod Autotroph
NaNO3 yield =0.2
NaNO3 yield =1.8
NaNO3 yield =1.7
NaNO3 yield =2.1
0
20
40
60
80
Time (h)

FIG. 13

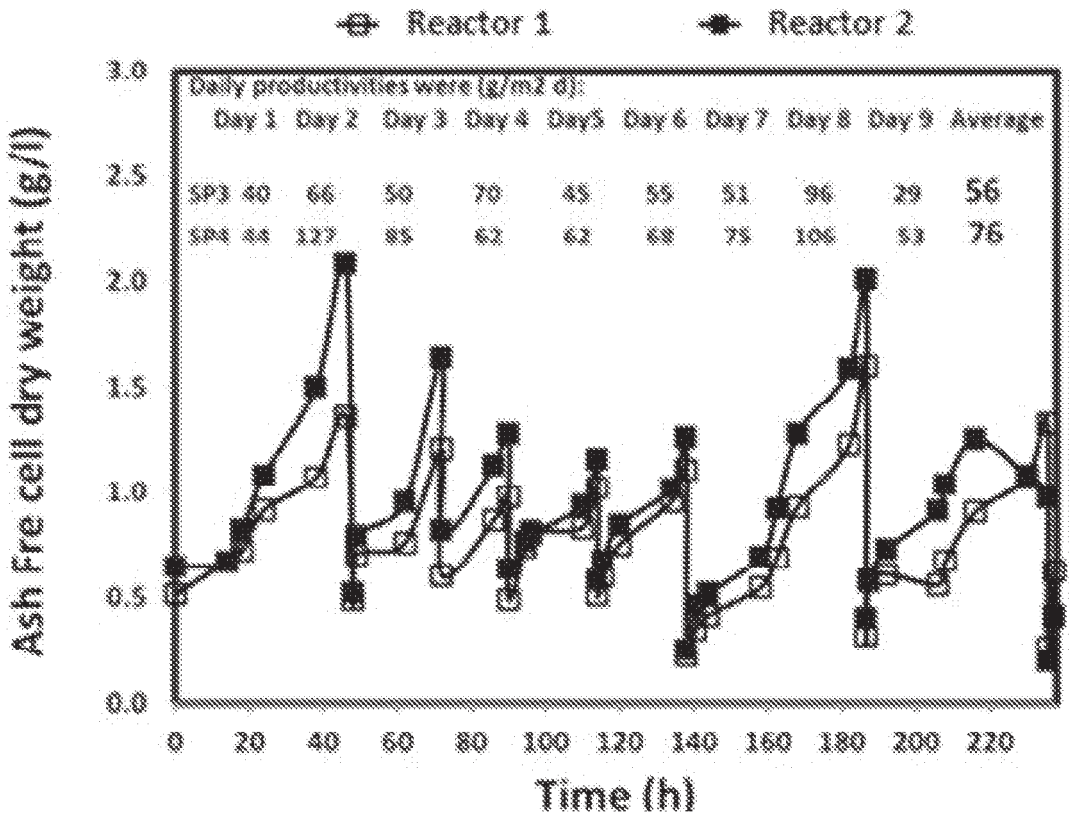

Reactor 1
Reactor 2
Daily productivities were (g/m2 d):
Day 1 Day 2 Day 3 Day 4 Day5 Day 6 Day 7 Day 8 Day 9 Average
SP3 40 66 50 70 45 55 51 96 29 56
SP4 44 137 85 62 62 68 75 106 53 76
Ash Fre cell dry weight (g/l)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0 20 40 60 80 100 120 140 160 180 200 220
Time (h)

FIG. 14

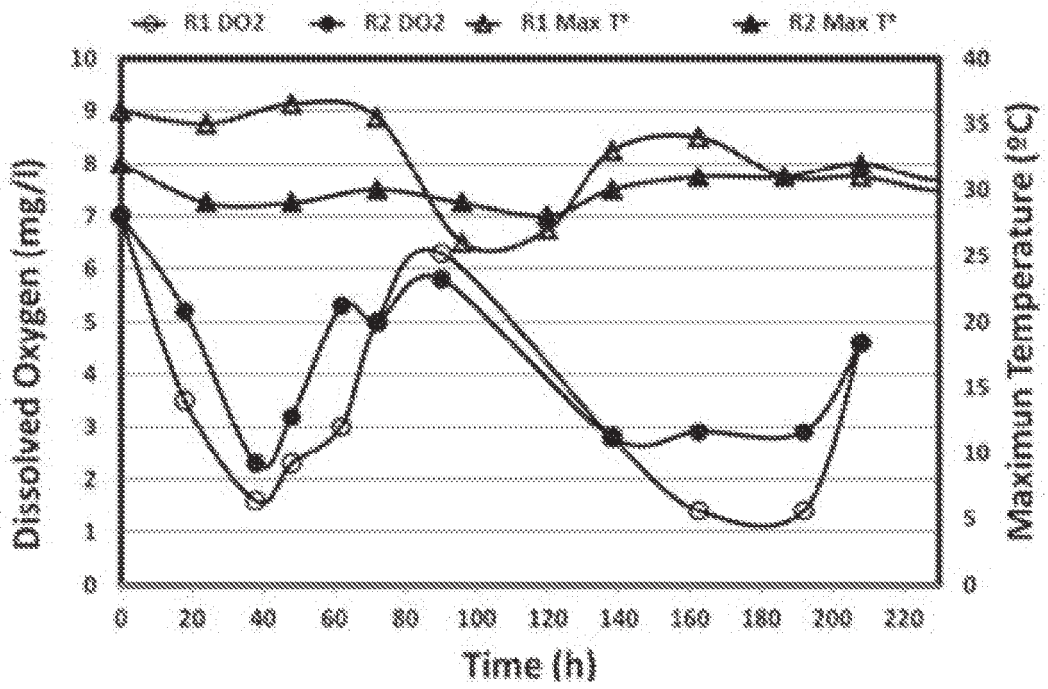

R1 DO2
R2 DO2
R1 Max T°
R2 Max T°
Dissolved Oxygen (mg/l)
Maximun Temperature (°C)
Time (h)
0
20
40
60
80
100
120
140
160
180
200
220
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40

FIG. 15

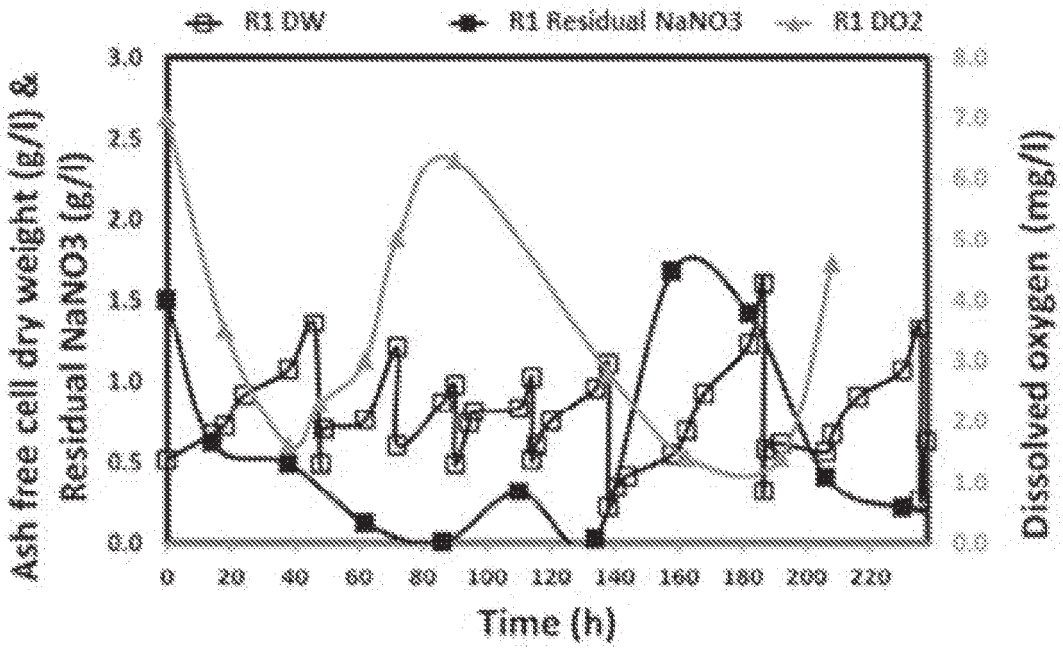

R1 DW
R1 Residual NaNO3
R1 DO2
Ash free cell dry weight (g/l) & Residual NaNO3 (g/l)
Dissolved oxygen (mg/l)
Time (h)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
0
20
40
60
80
100
120
140
160
180
200
220

FIG. 16

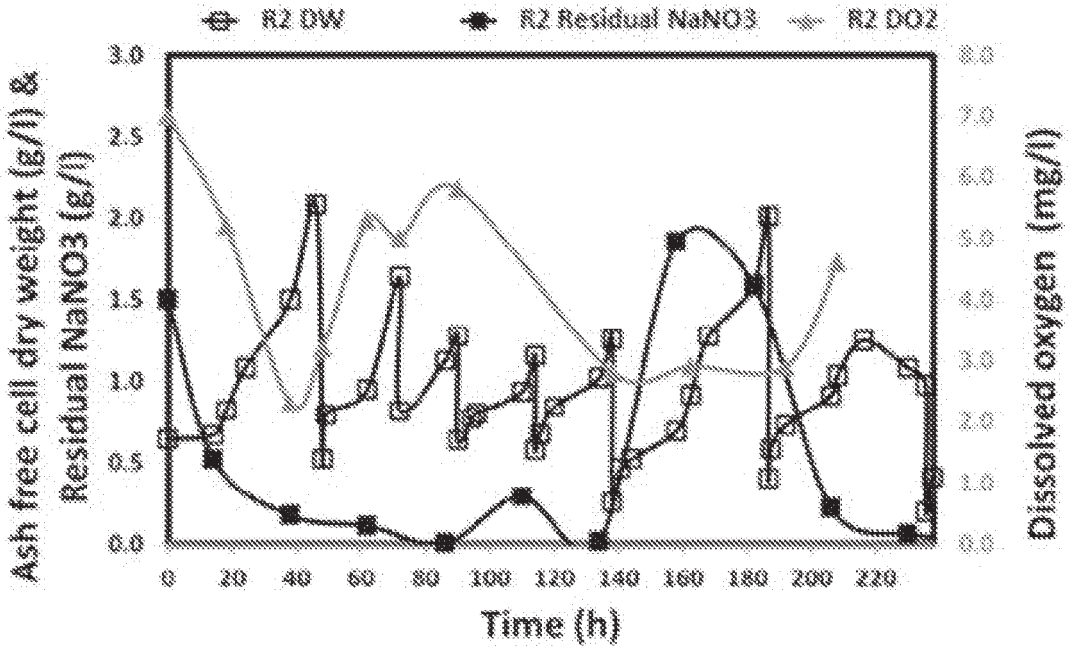

R2 DW
R2 Residual NaNO3
R2 DO2
Ash free cell dry weight (g/l) & Residual NaNO3 (g/l)
Dissolved oxygen (mg/l)
Time (h)
0
20
40
60
80
100
120
140
160
180
200
220
0.0
0.5
1.0
1.5
2.0
2.5
3.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0

FIG. 17

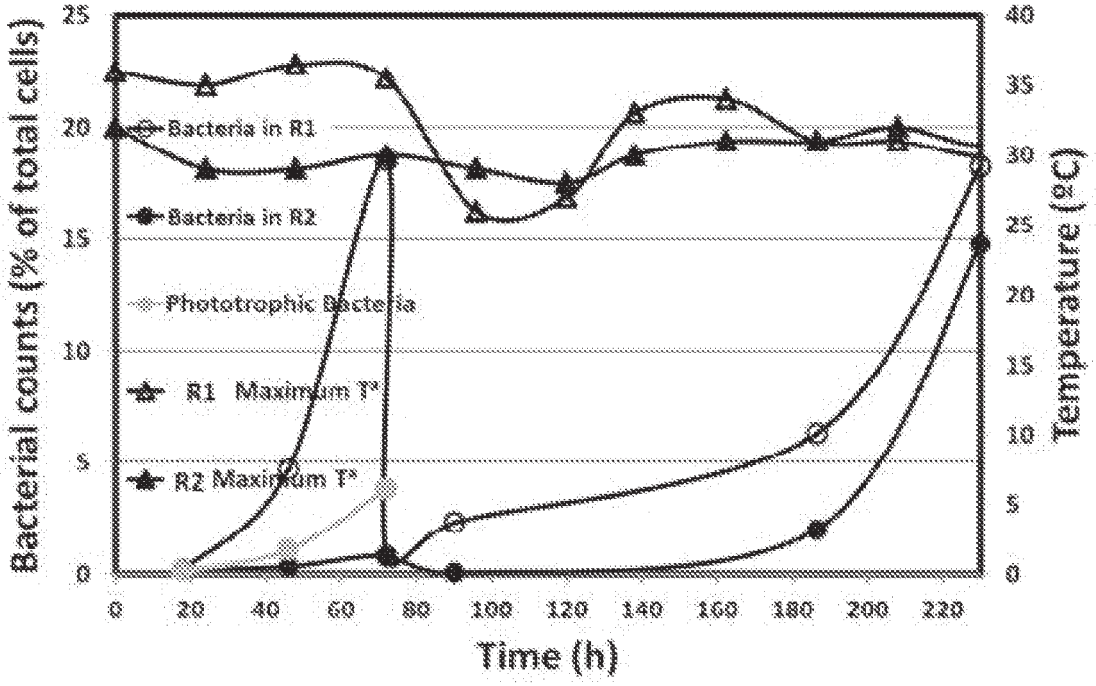

Bacterial counts (% of total cells)
Temperature (ºC)
Time (h)
Bacteria in R1
Bacteria in R2
Phototrophic Bacteria
R1 Maximum T°
R2 Maximum T°
0
5
10
15
20
25
30
35
40
0
20
40
60
80
100
120
140
160
180
200
220

FIG. 18

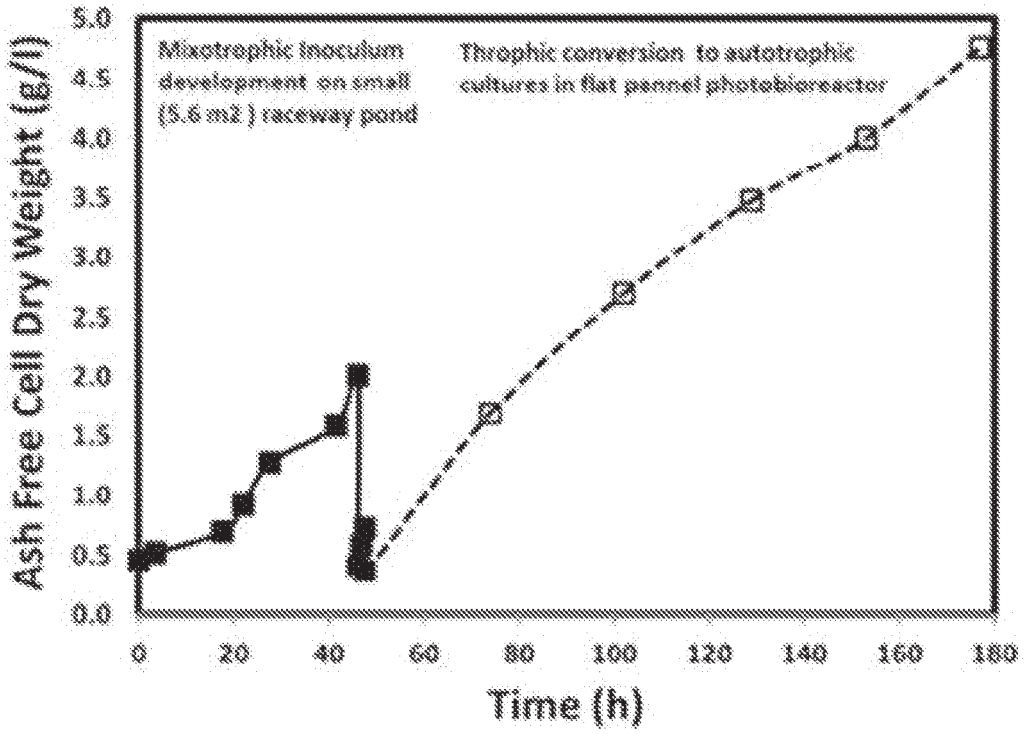

Ash Free Cell Dry Weight (g/l)
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Mixotrophic inoculum development on small (5.6 m2 ) raceway pond
Throphic conversion to autotrophic cultures in flat pannel photobioreactor
0
20
40
60
80
100
120
140
160
180
Time (h)

FIG. 19

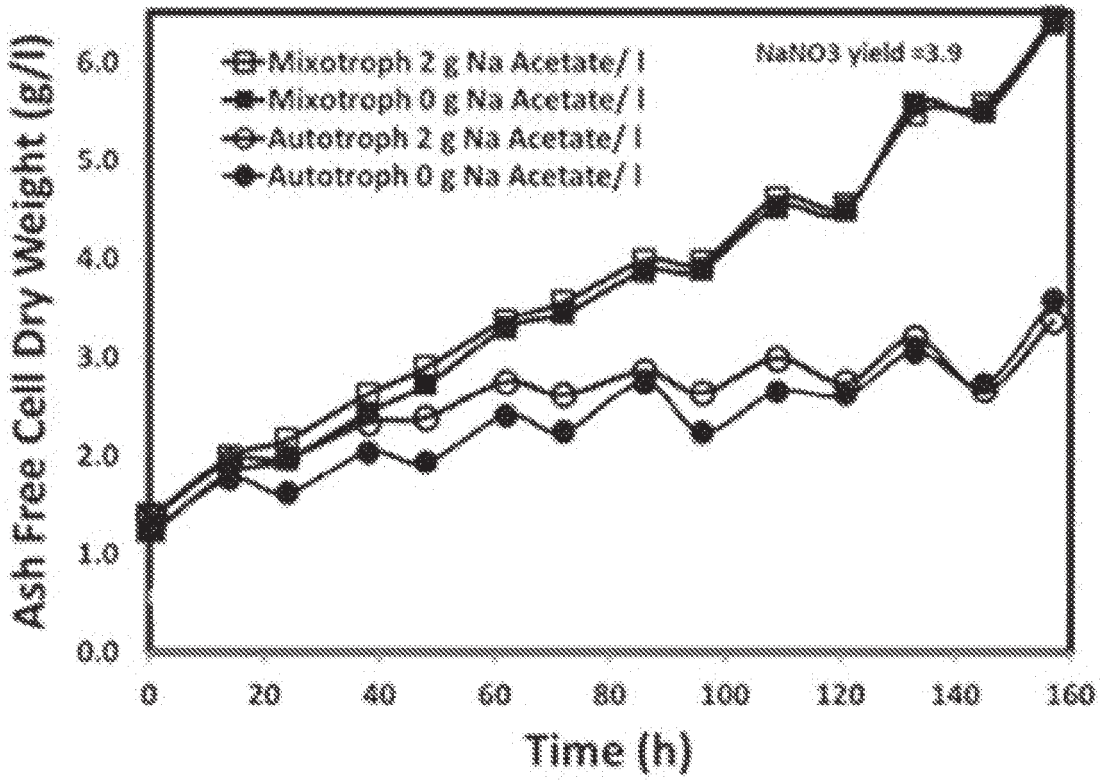

Mixotroph 2 g Na Acetate/ l
Mixotroph 0 g Na Acetate/ l
Autotroph 2 g Na Acetate/ l
Autotroph 0 g Na Acetate/ l
NaNO3 yield =3.9
Ash Free Cell Dry Weight (g/l)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
20
40
60
80
100
120
140
160
Time (h)

FIG. 20

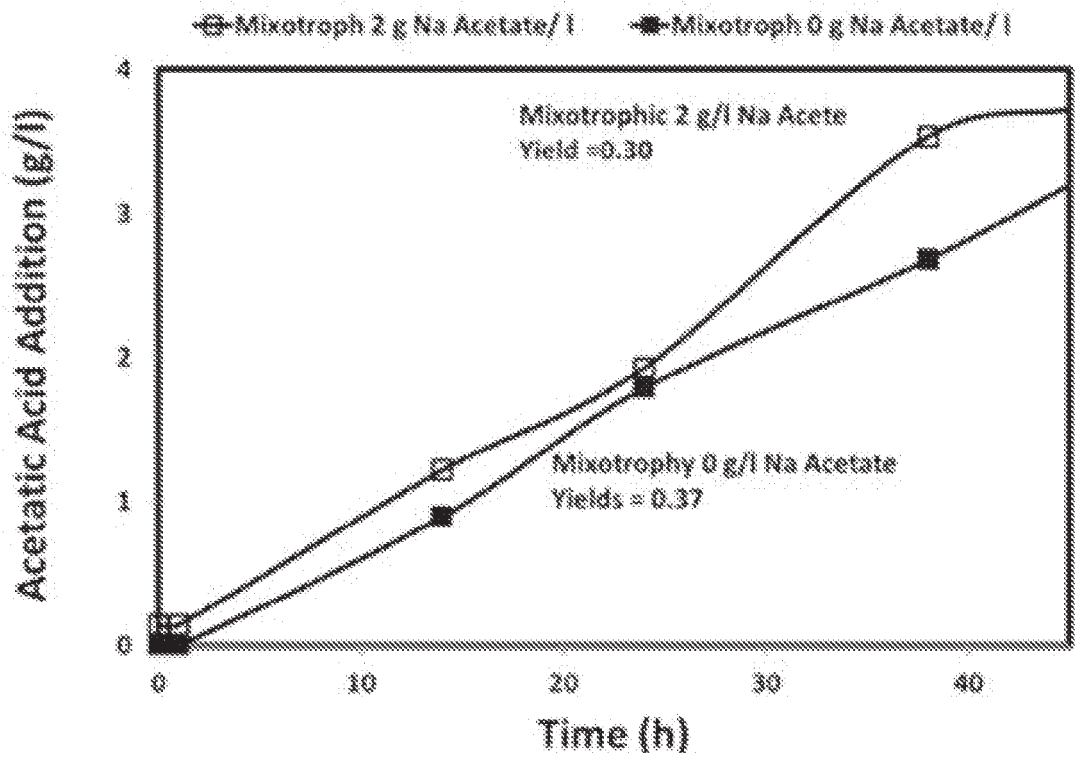

Mixotroph 2 g Na Acetate/ l
Mixotroph 0 g Na Acetate/ l
Acetatic Acid Addition (g/l)
Mixotrophic 2 g/l Na Acete
Yield =0.30
Mixotrophy 0 g/l Na Acetate
Yields = 0.37
0
1
2
3
4
0
10
20
30
40
Time (h)

FIG. 21

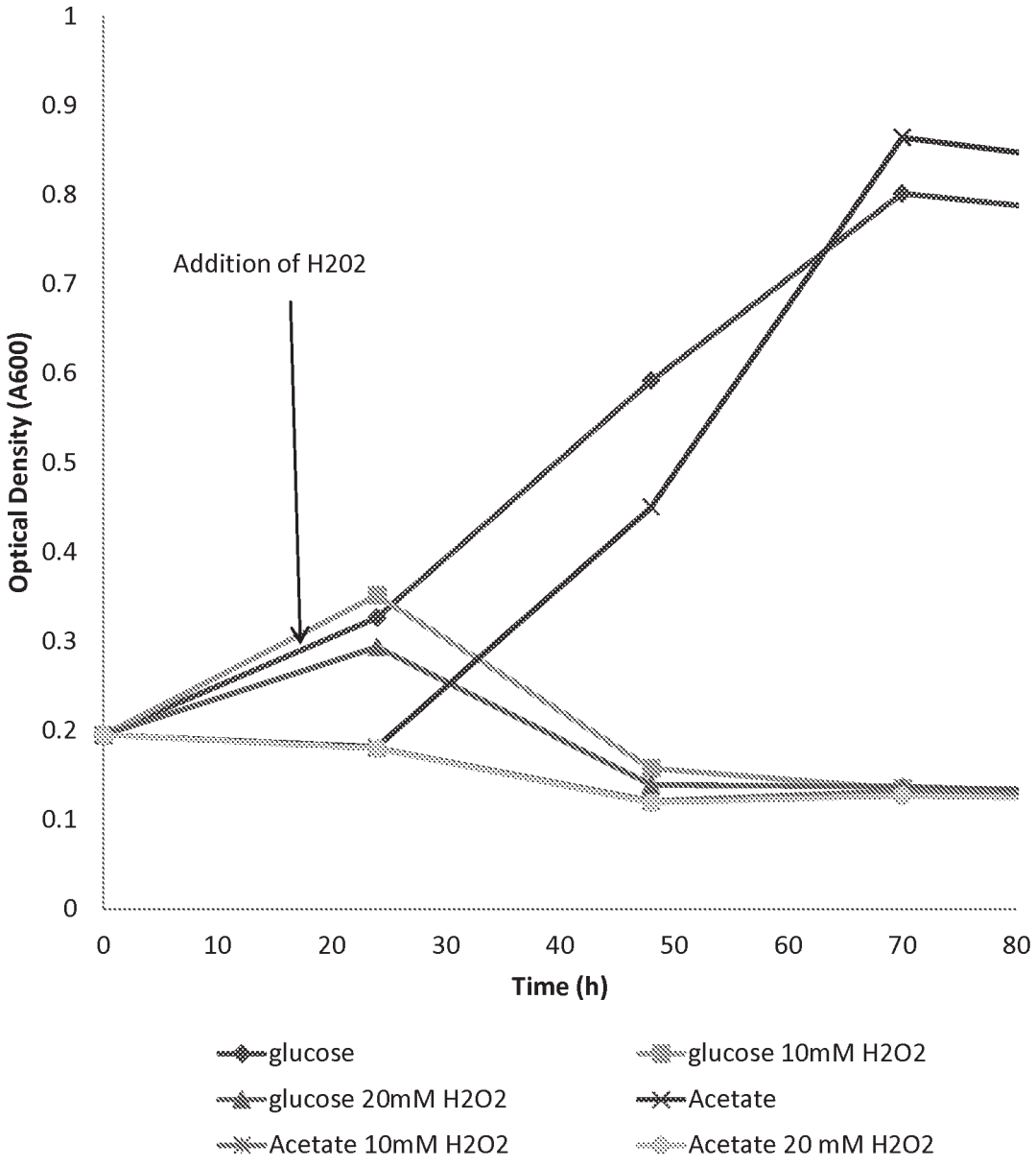

Optical Density (A600)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Addition of H202
0
10
20
30
40
50
60
70
80
Time (h)
glucose
glucose 10mM H2O2
glucose 20mM H2O2
Acetate
Acetate 10mM H2O2
Acetate 20 mM H2O2

FIG. 22

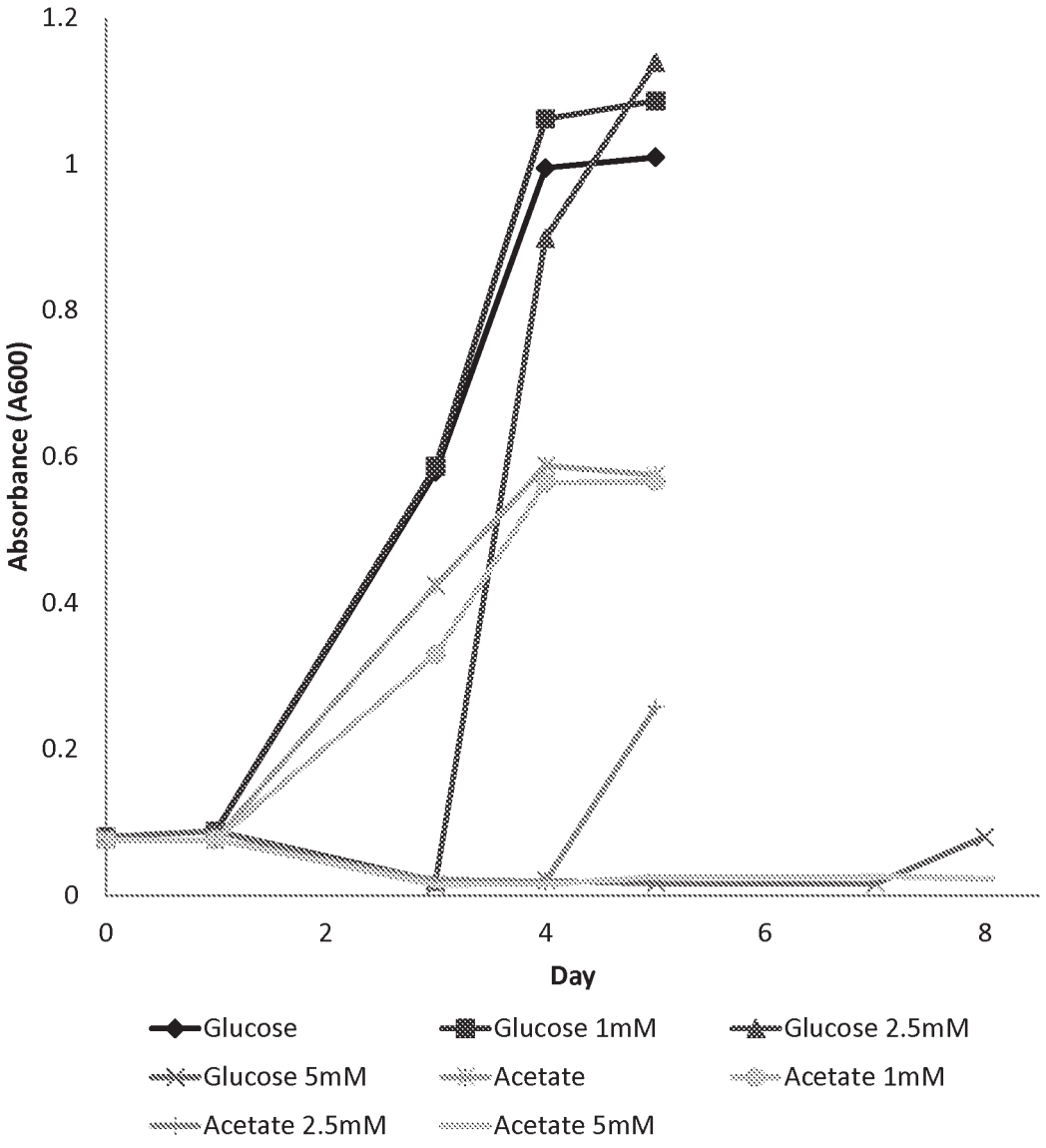

1.2
1
0.8
0.6
0.4
0.2
0
Absorbance (A600)
0
2
4
6
8
Day
Glucose
Glucose 1mM
Glucose 2.5mM
Glucose 5mM
Acetate
Acetate 1mM
Acetate 2.5mM
Acetate 5mM

FIG. 23

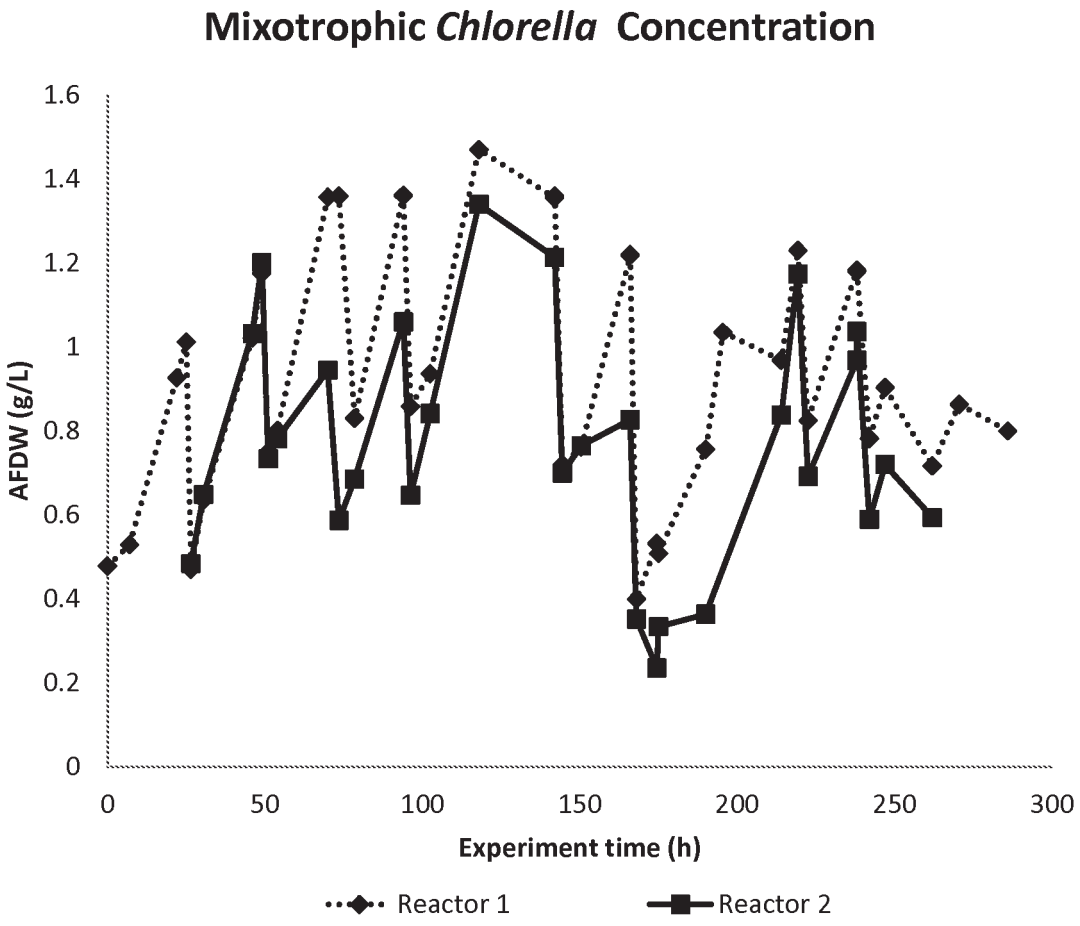

Mixotrophic *Chlorella* Concentration
AFDW (g/L)
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
Experiment time (h)
Reactor 1
Reactor 2

FIG. 24

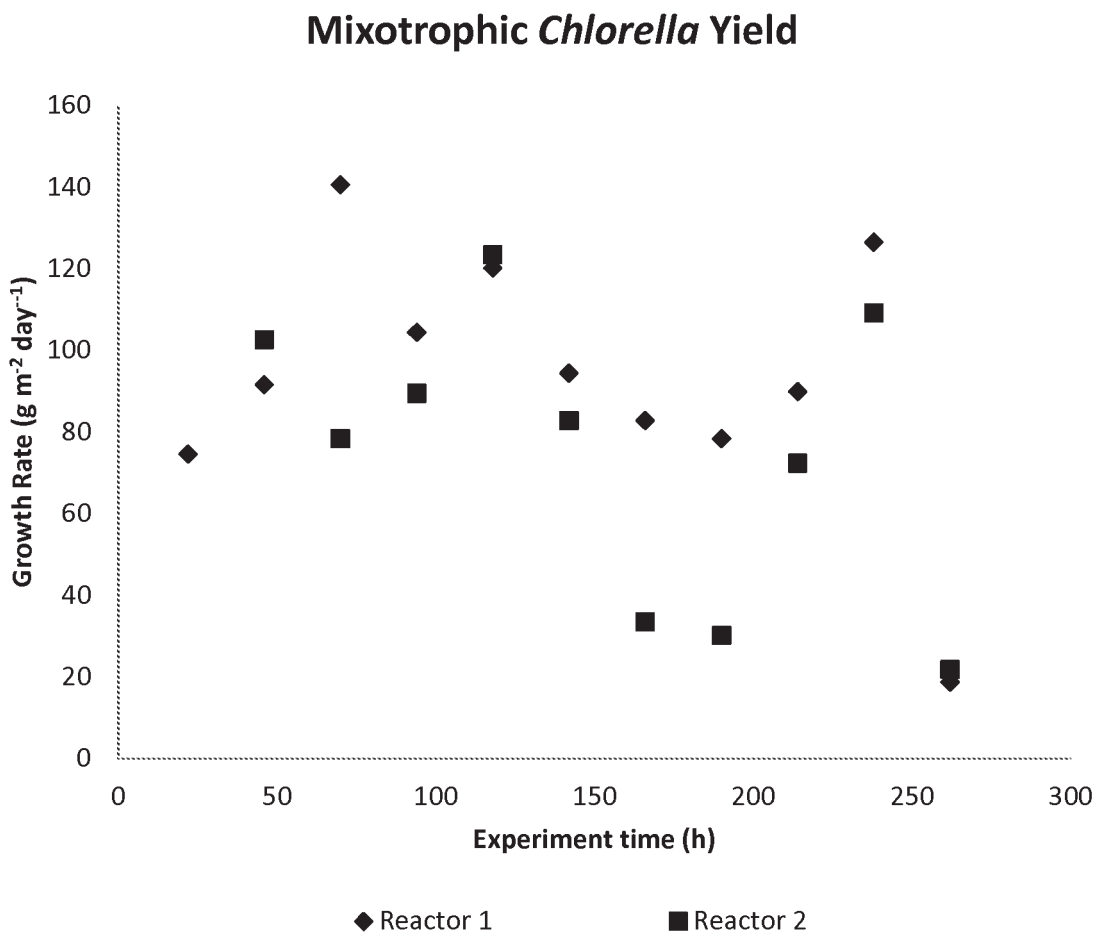

Mixotrophic *Chlorella* Yield
Growth Rate (g m-2 day-1)
160
140
120
100
80
60
40
20
0
0
50
100
150
200
250
300
Experiment time (h)
Reactor 1
Reactor 2

FIG. 25

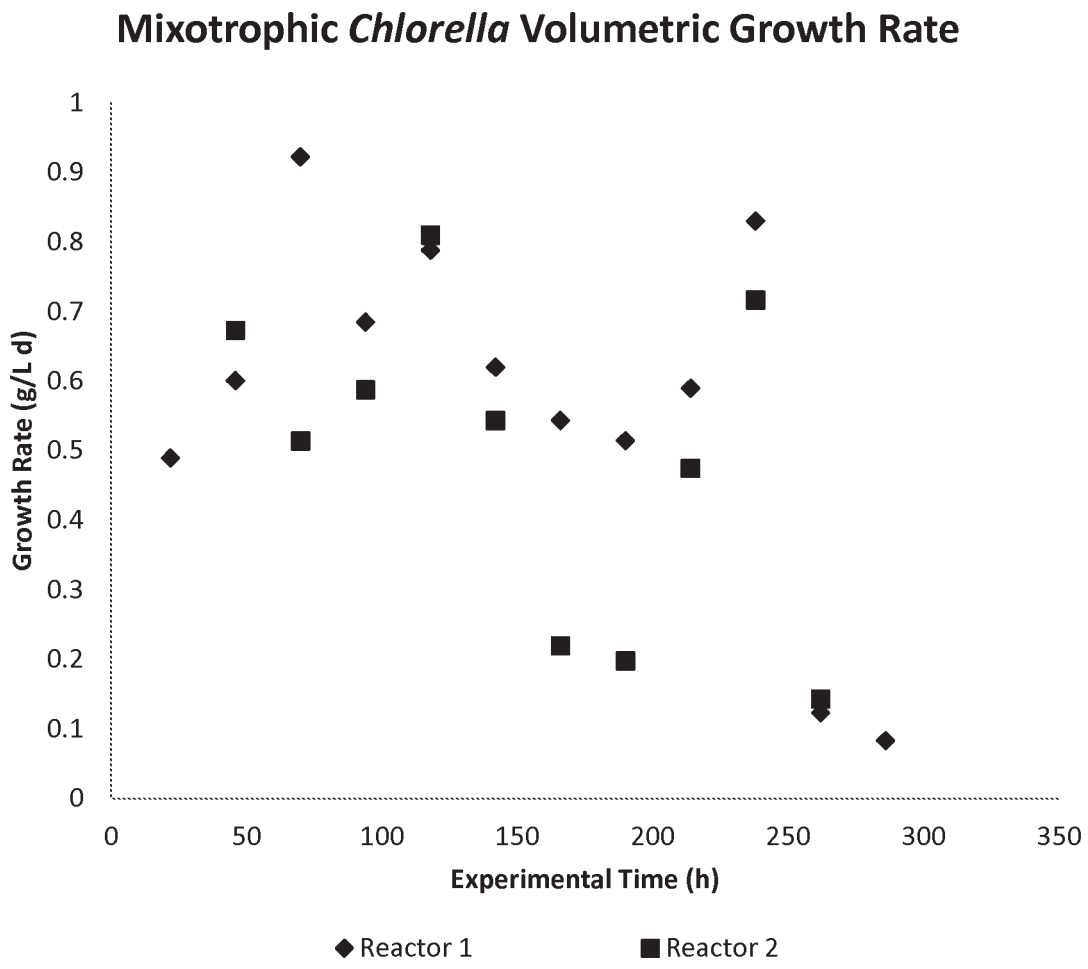

Mixotrophic *Chlorella* Volumetric Growth Rate
Growth Rate (g/L d)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300
350
Experimental Time (h)
Reactor 1
Reactor 2

FIG. 26

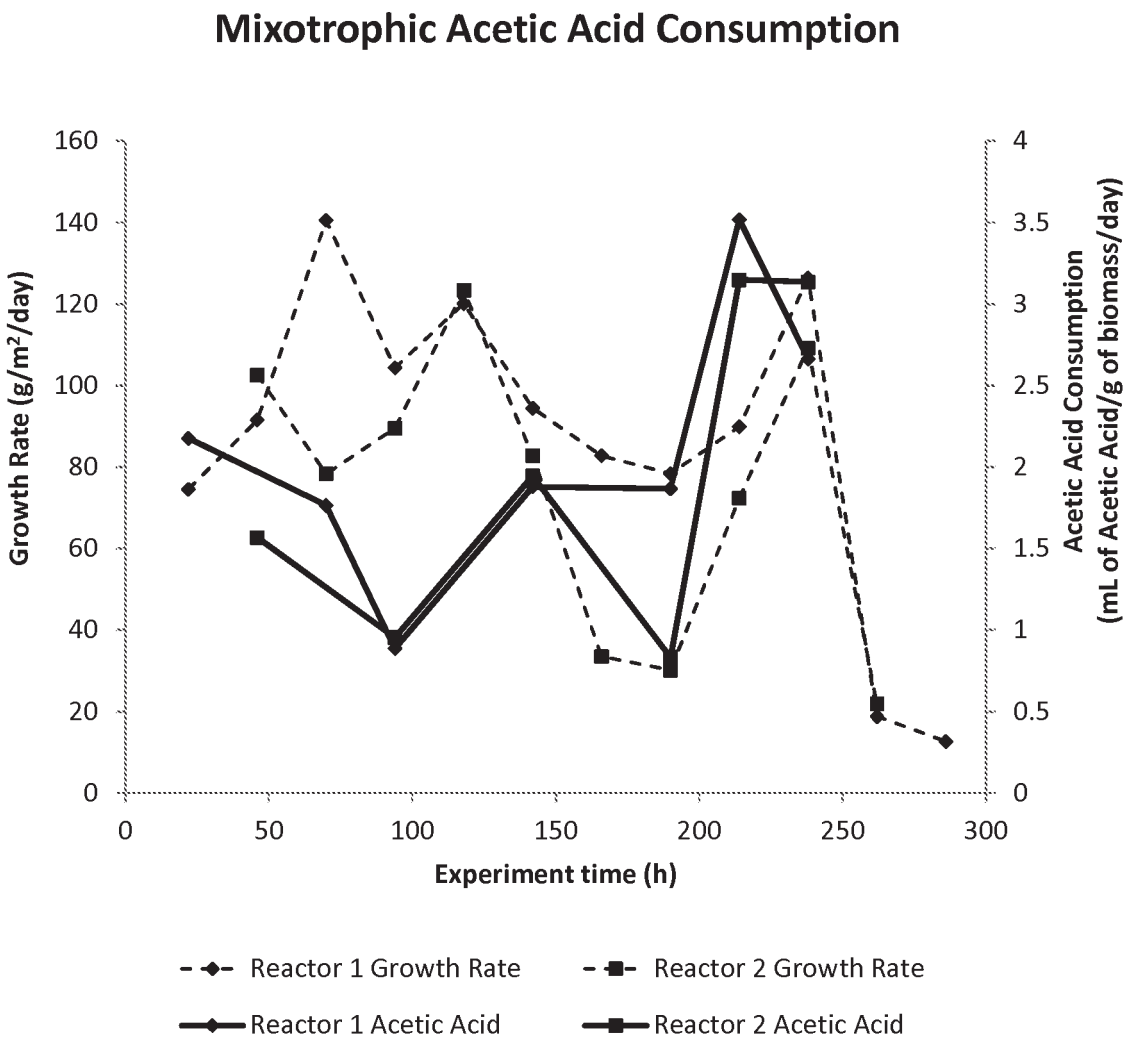

Mixotrophic Acetic Acid Consumption
Growth Rate (g/m²/day)
Acetic Acid Consumption (mL of Acetic Acid/g of biomass/day)
Experiment time (h)
0
20
40
60
80
100
120
140
160
0
0.5
1
1.5
2
2.5
3
3.5
4
0
50
100
150
200
250
300
Reactor 1 Growth Rate
Reactor 2 Growth Rate
Reactor 1 Acetic Acid
Reactor 2 Acetic Acid

FIG. 27

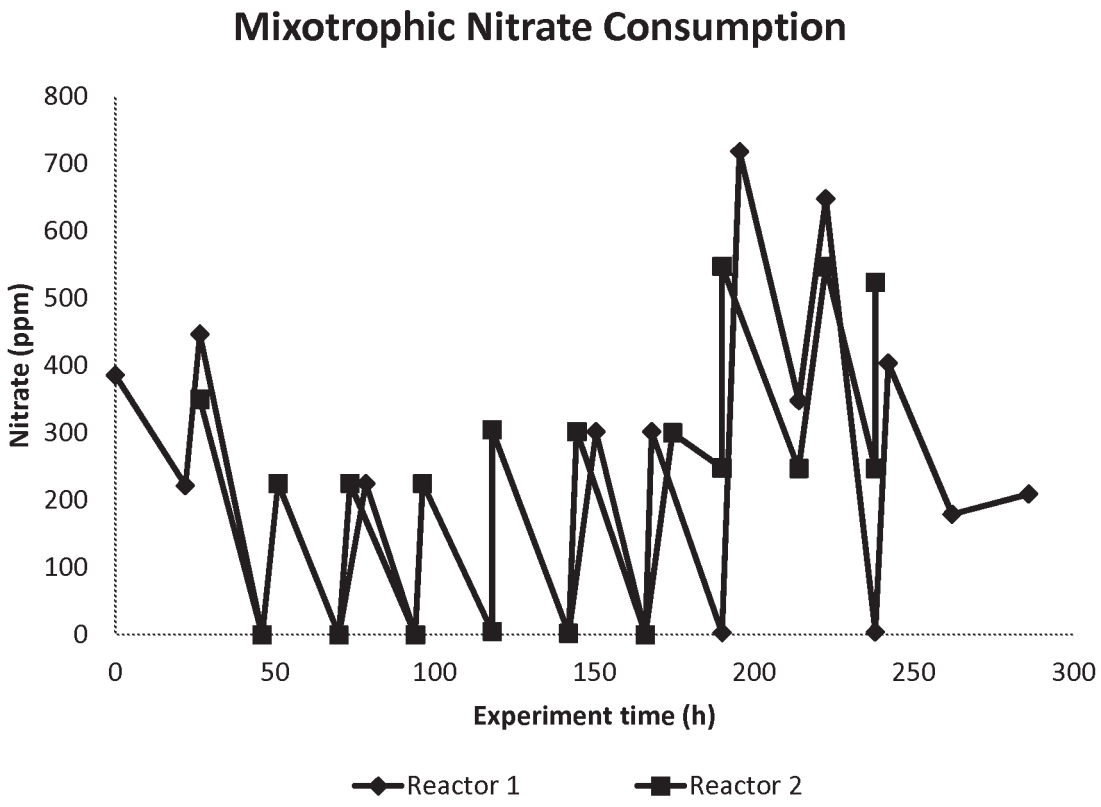

Mixotrophic Nitrate Consumption
Nitrate (ppm)
800
700
600
500
400
300
200
100
0
0
50
100
150
200
250
300
Experiment time (h)
Reactor 1
Reactor 2

FIG. 28

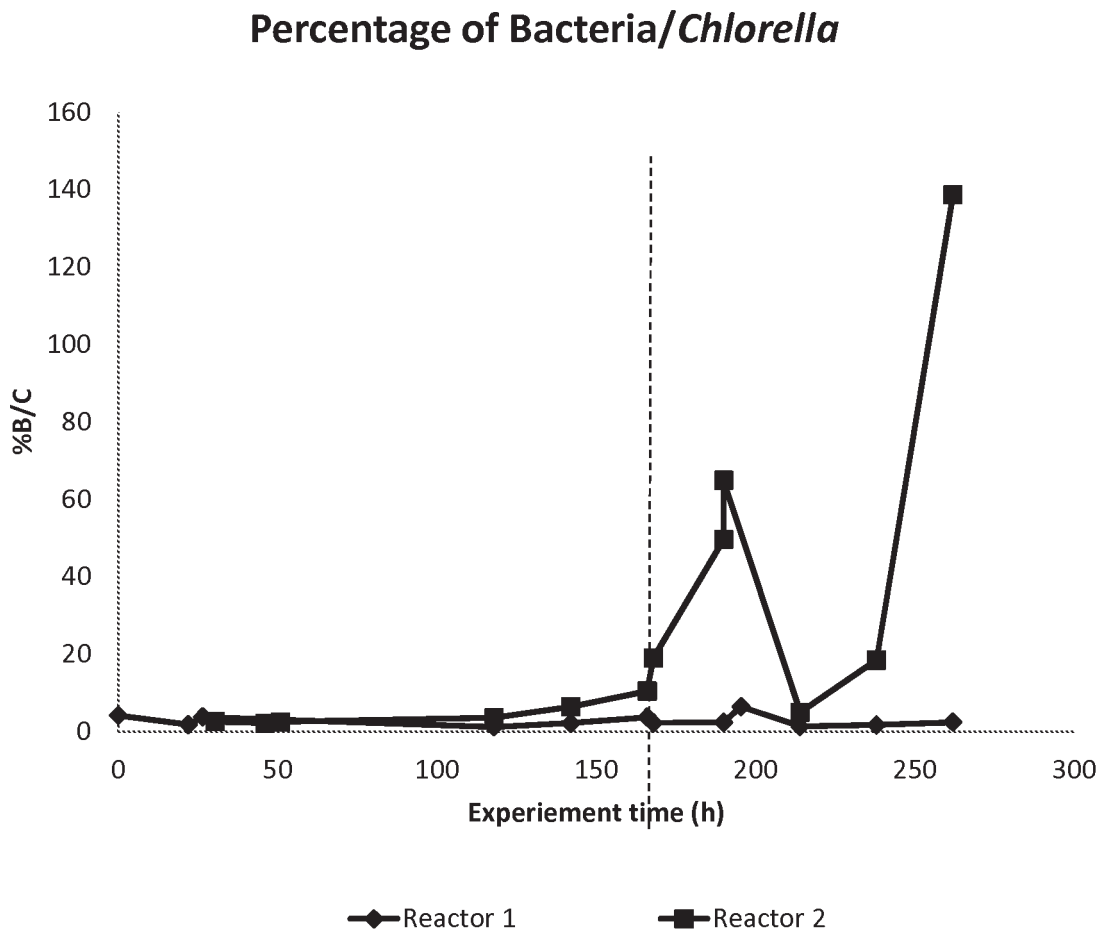

Percentage of Bacteria/Chlorella
%B/C
160
140
120
100
80
60
40
20
0
0
50
100
150
200
250
300
Experiement time (h)
Reactor 1
Reactor 2

FIG. 29

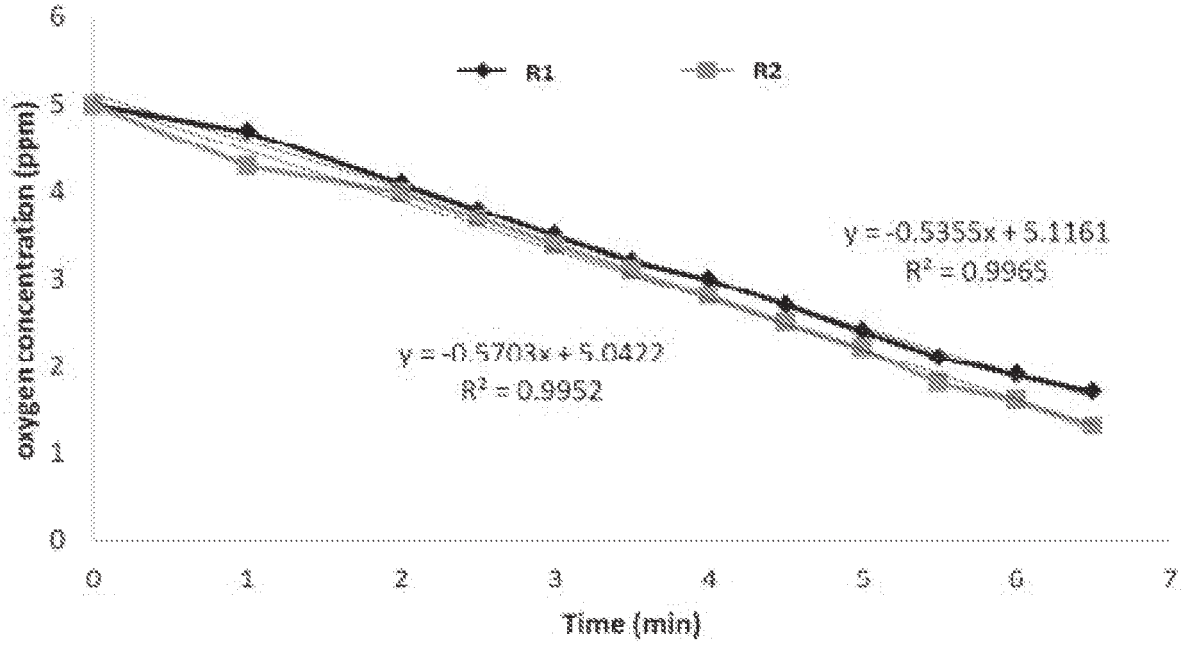

R1
R2
y = -0.5355x + 5.1161
R² = 0.9965
y = -0.5703x + 5.0422
R² = 0.9952
oxygen concentration (ppm)
Time (min)
0
1
2
3
4
5
6
7

FIG. 30

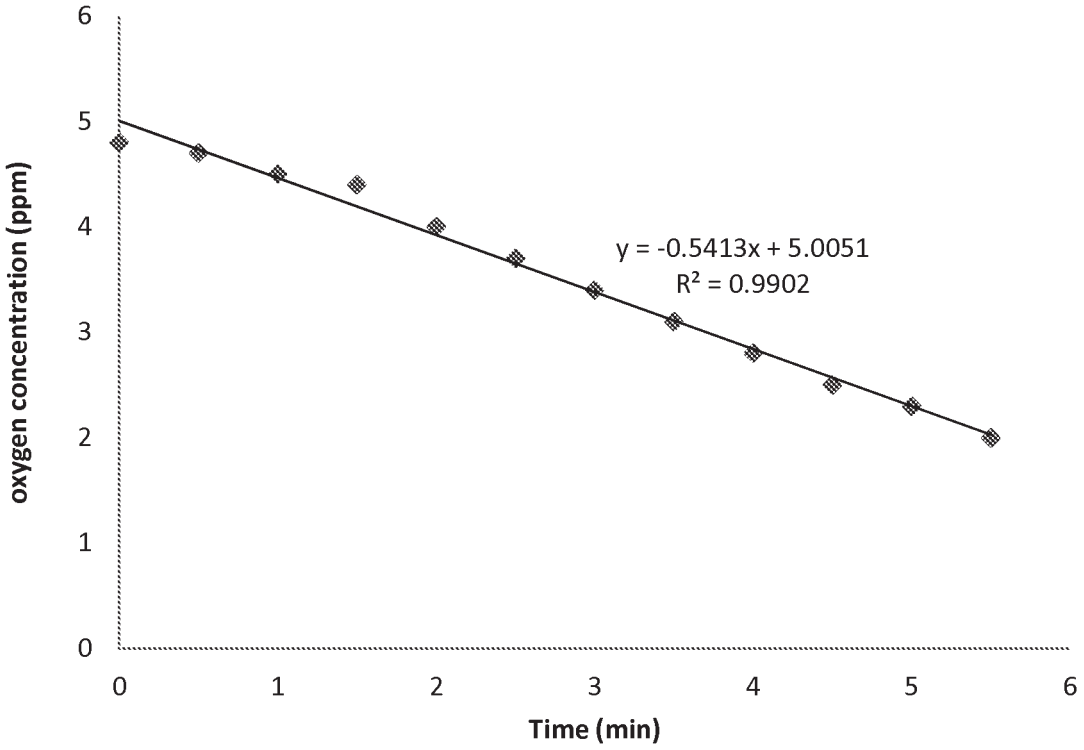

oxygen concentration (ppm)
Time (min)
y = -0.5413x + 5.0051
R² = 0.9902
0
1
2
3
4
5
6

FIG. 31

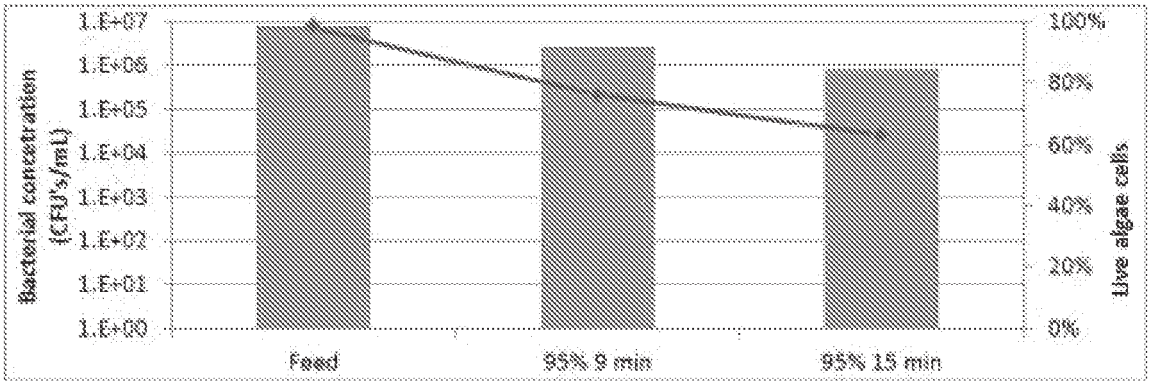

Bacterial concentration (CFU's/mL)
1.E+07
1.E+06
1.E+05
1.E+04
1.E+03
1.E+02
1.E+01
1.E+00
100%
80%
60%
40%
20%
0%
Live algae cells
Feed
95% 9 min
95% 15 min

FIG. 32

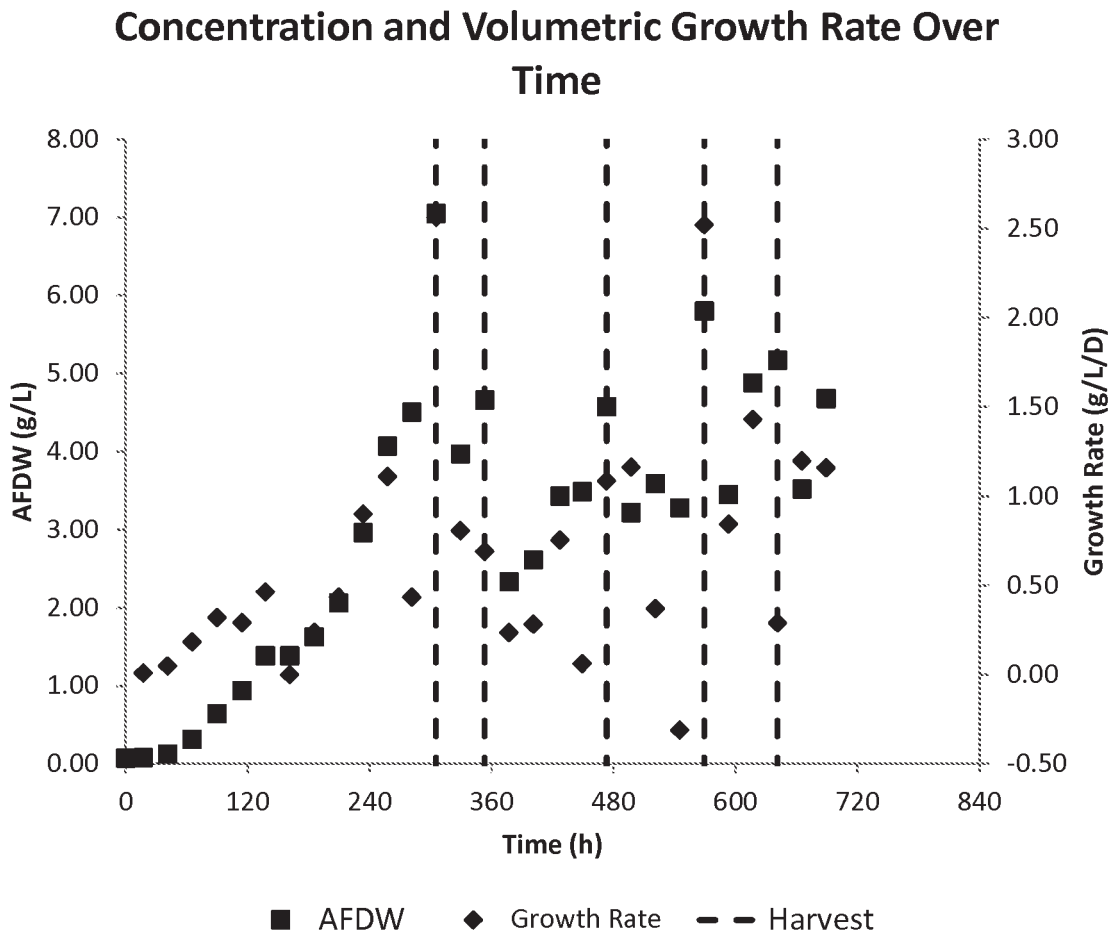

Concentration and Volumetric Growth Rate Over Time
AFDW (g/L)
Growth Rate (g/L/D)
Time (h)
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
0
120
240
360
480
600
720
840
AFDW
Growth Rate
Harvest

FIG. 33

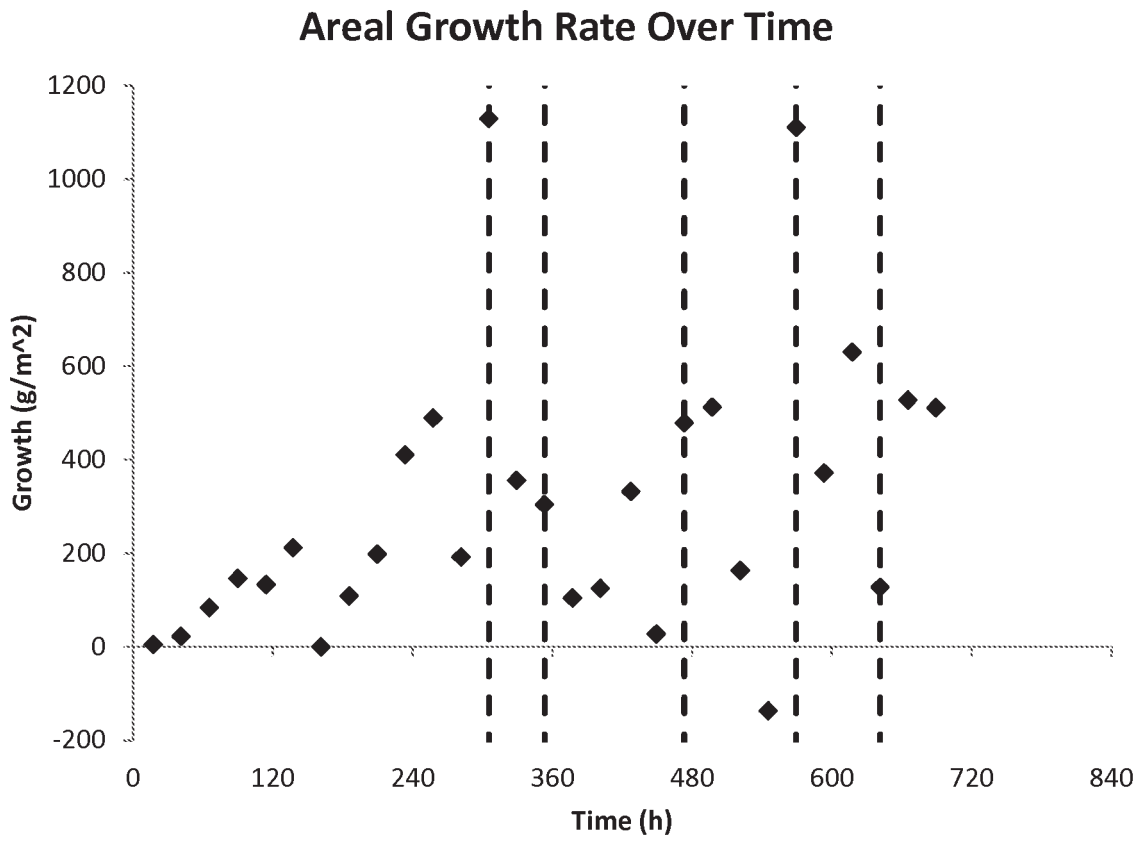

Areal Growth Rate Over Time
Growth (g/m^2)
1200
1000
800
600
400
200
0
-200
0
120
240
360
480
600
720
840
Time (h)

FIG. 34

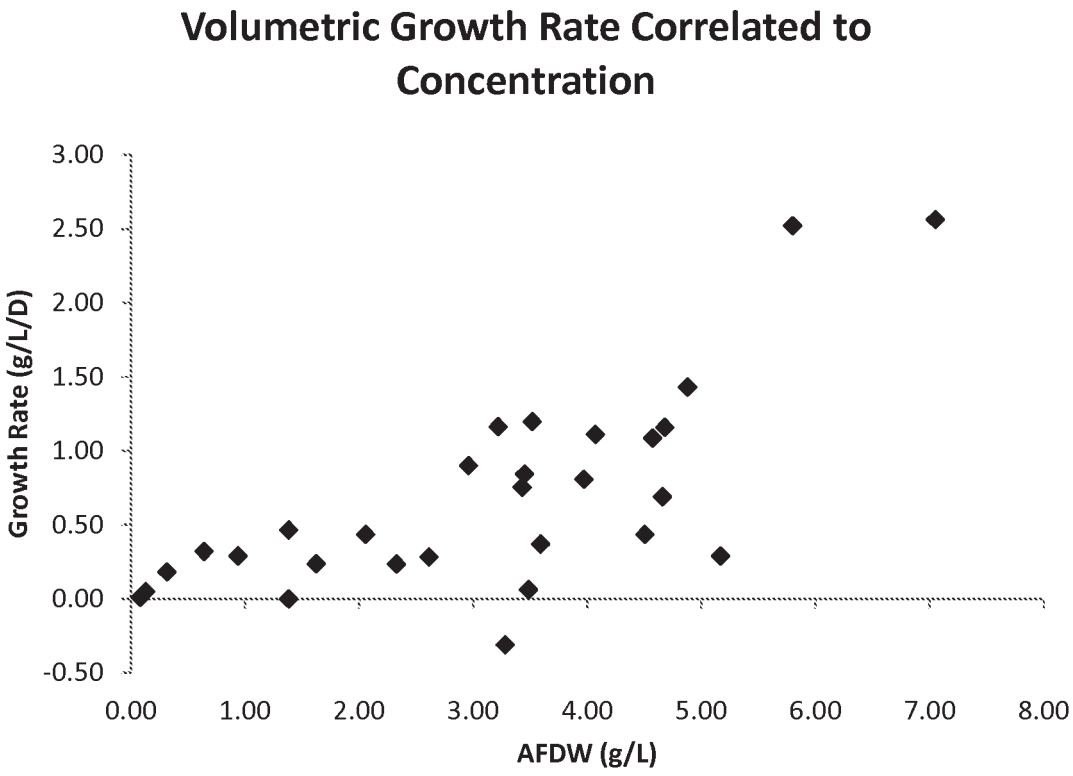

Volumetric Growth Rate Correlated to Concentration
Growth Rate (g/L/D)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
-0.50
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
AFDW (g/L)

FIG. 35

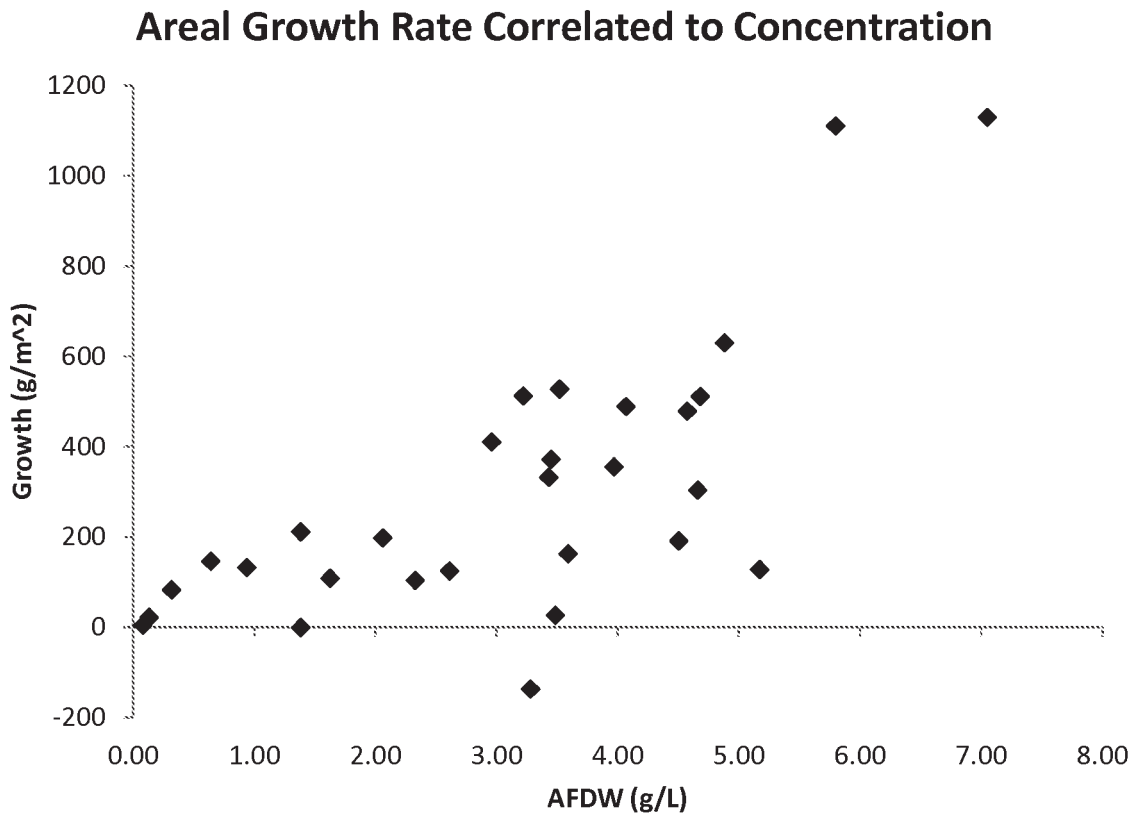

Areal Growth Rate Correlated to Concentration
Growth (g/m^2)
1200
1000
800
600
400
200
0
-200
0.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
AFDW (g/L)

FIG. 36

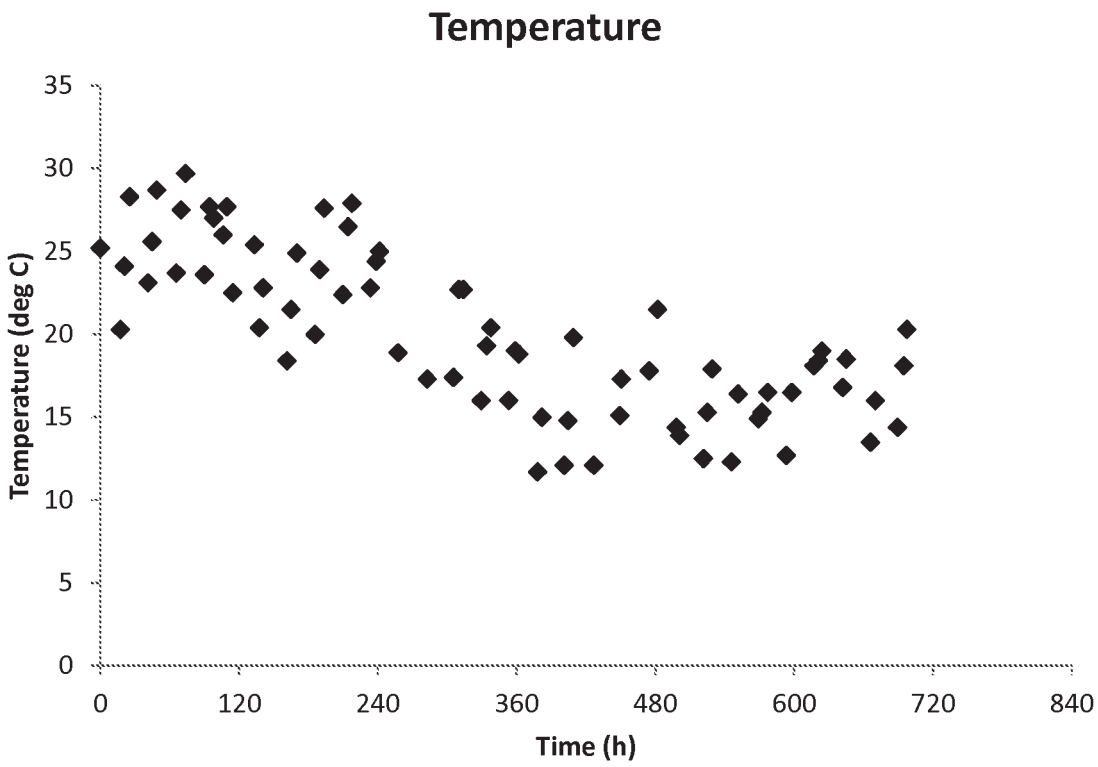

Temperature
Temperature (deg C)
35
30
25
20
15
10
5
0
0
120
240
360
480
600
720
840
Time (h)

FIG. 37

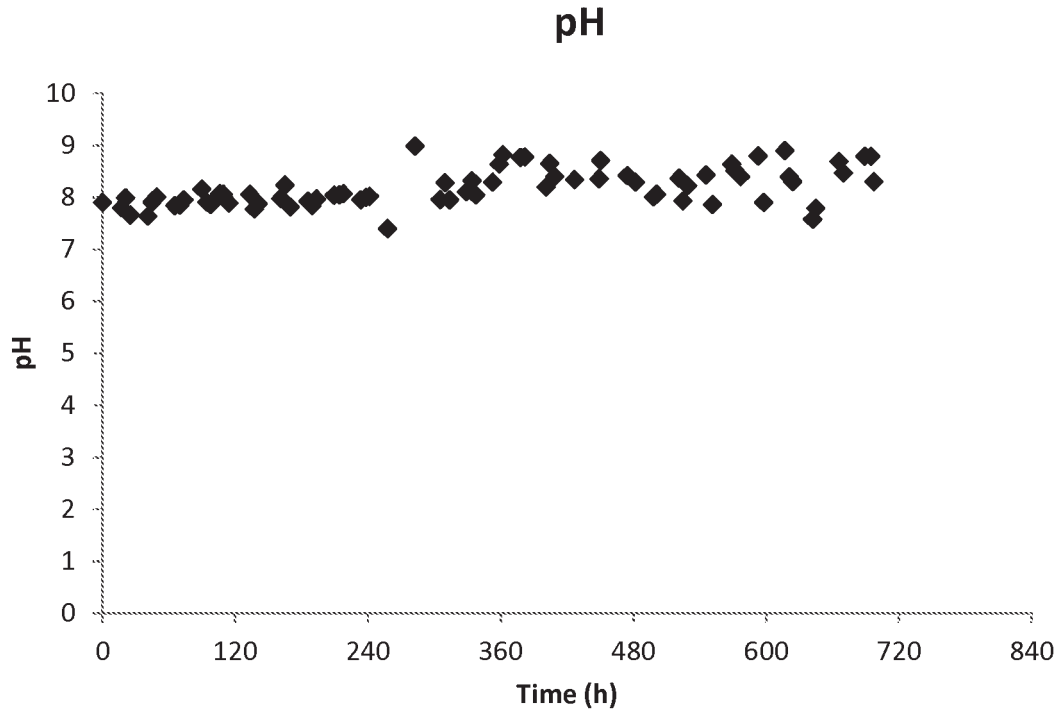


FIG. 38

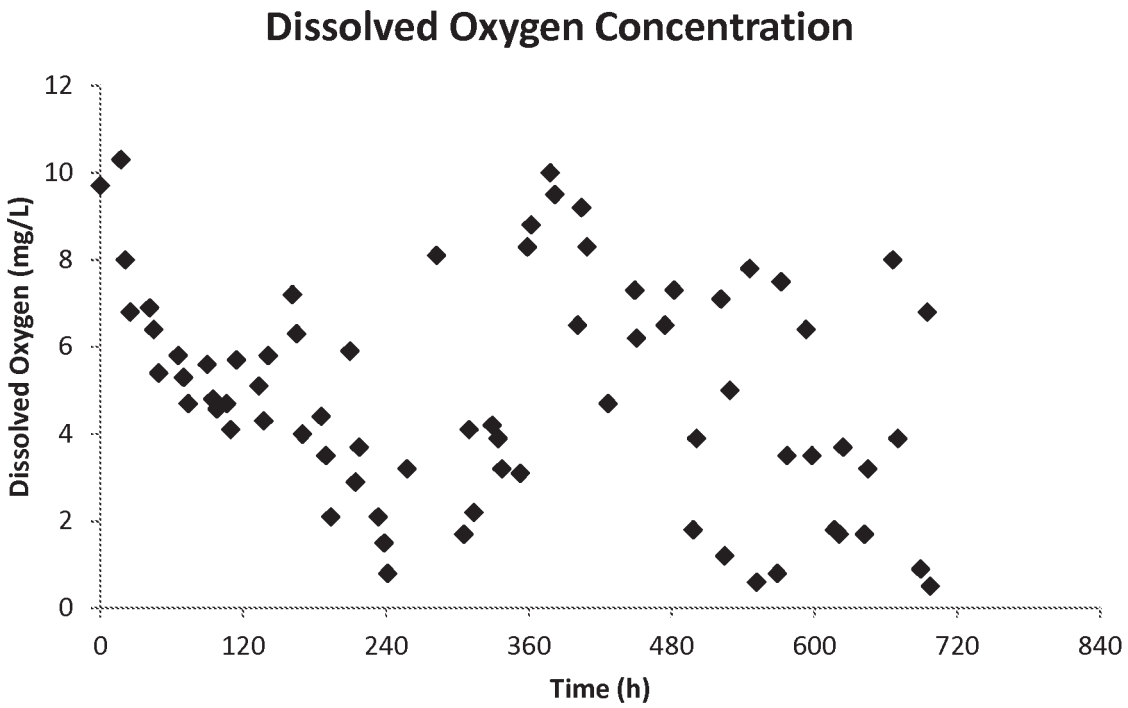

Dissolved Oxygen Concentration
Dissolved Oxygen (mg/L)
0
2
4
6
8
10
12
0
120
240
360
480
600
720
840
Time (h)

FIG. 39

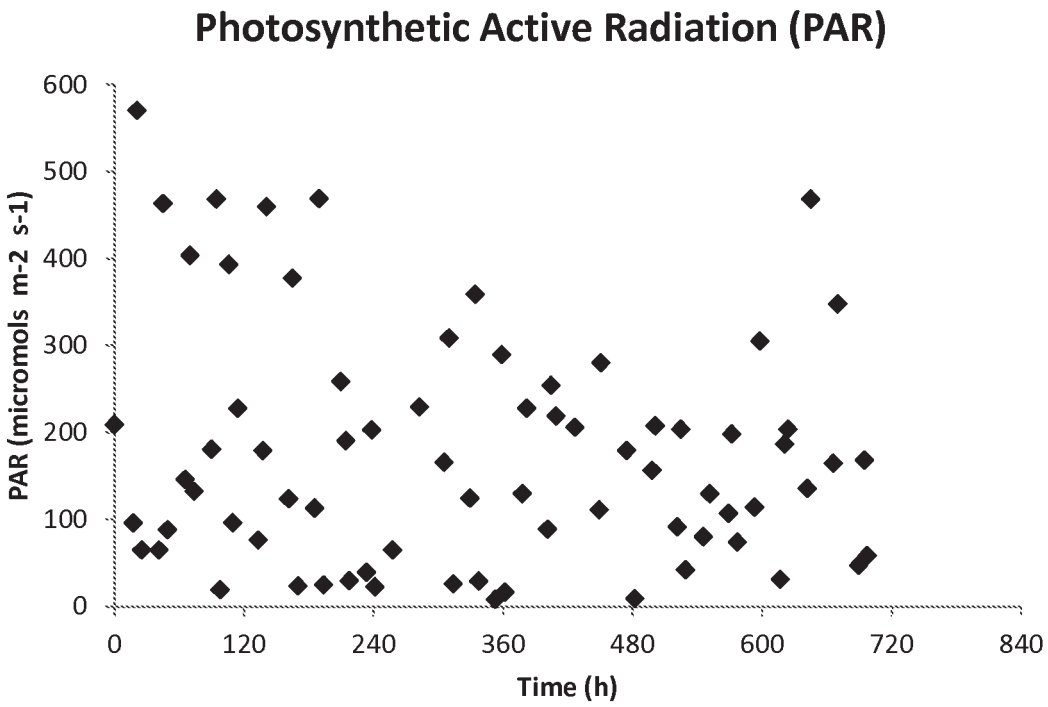

Photosynthetic Active Radiation (PAR)
PAR (micromols m-2 s-1)
600
500
400
300
200
100
0
0
120
240
360
480
600
720
840
Time (h)

FIG. 40

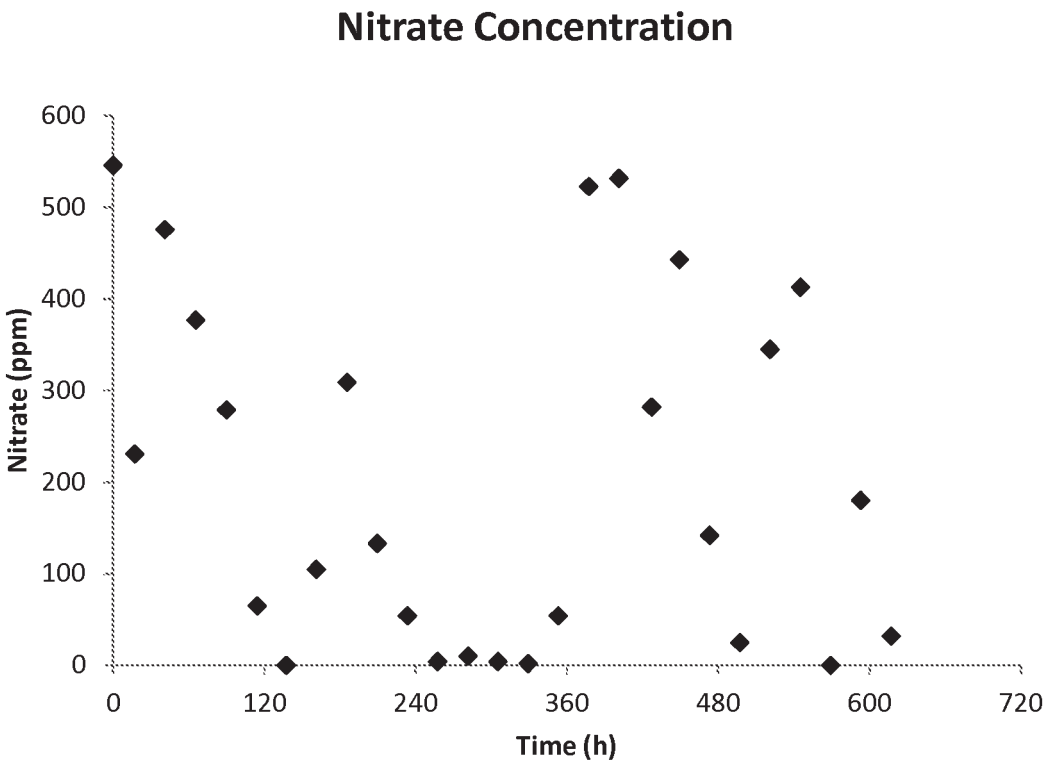
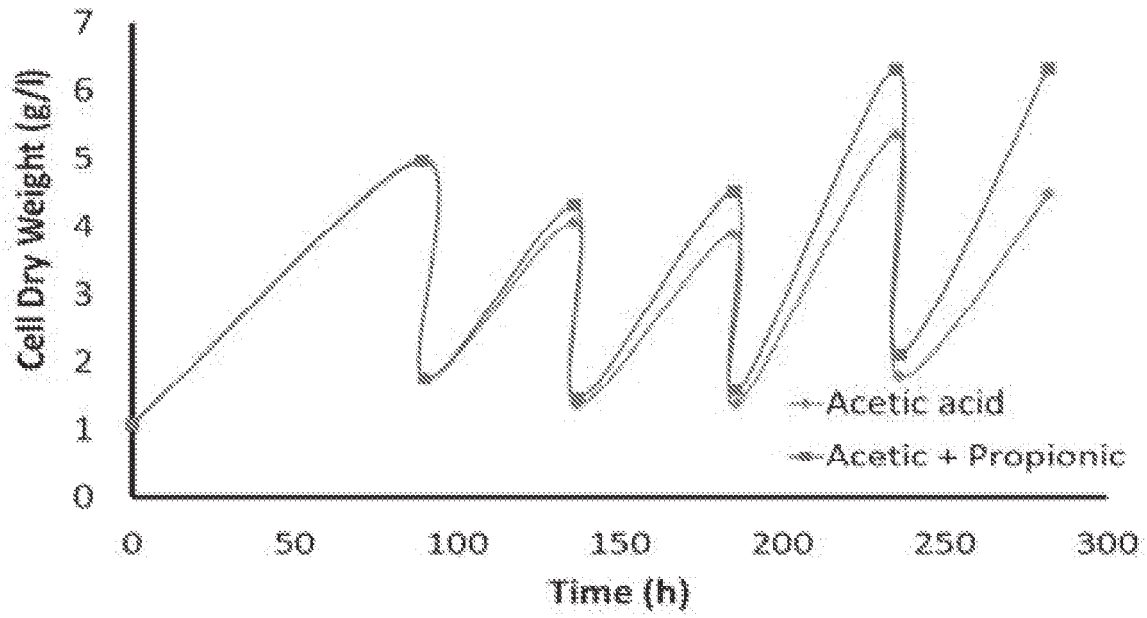

Nitrate Concentration
Nitrate (ppm)
600
500
400
300
200
100
0
0
120
240
360
480
600
720
Time (h)

FIG. 41


Cell Dry Weight (g/l)
0
1
2
3
4
5
6
7
0
50
100
150
200
250
300
Time (h)
Acetic acid
Acetic + Propionic