Figure 1

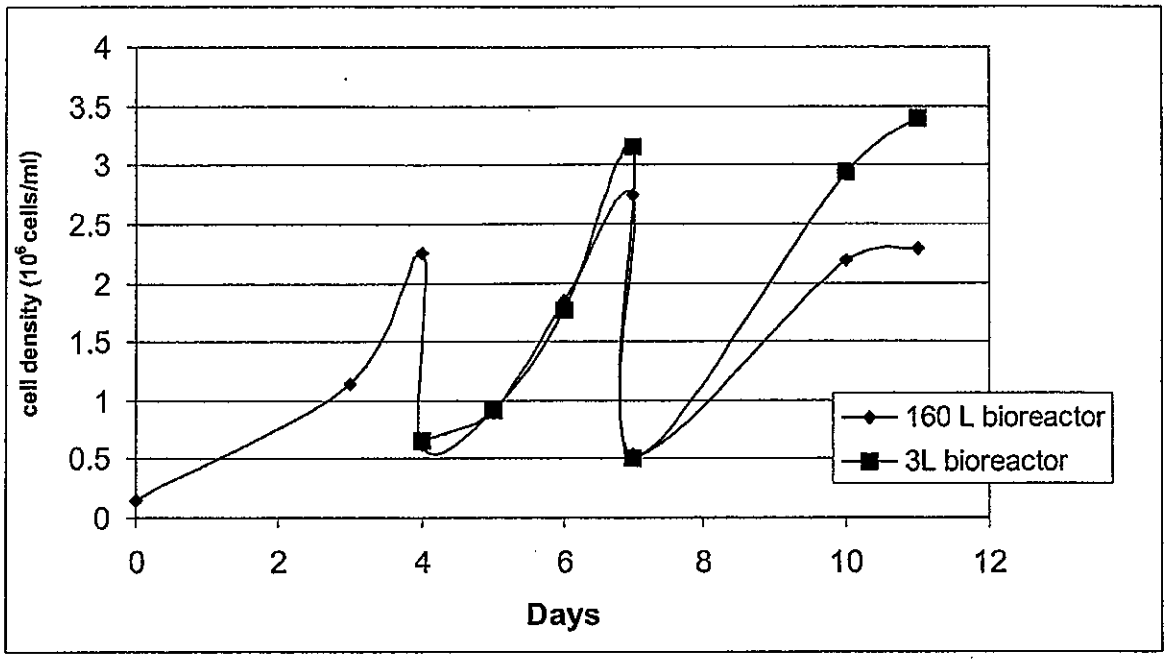

cell density (10^6 cells/ml)
4
3.5
3
2.5
2
1.5
1
0.5
0
0
2
4
6
8
10
12
Days
160 L bioreactor
3L bioreactor

Figure 2

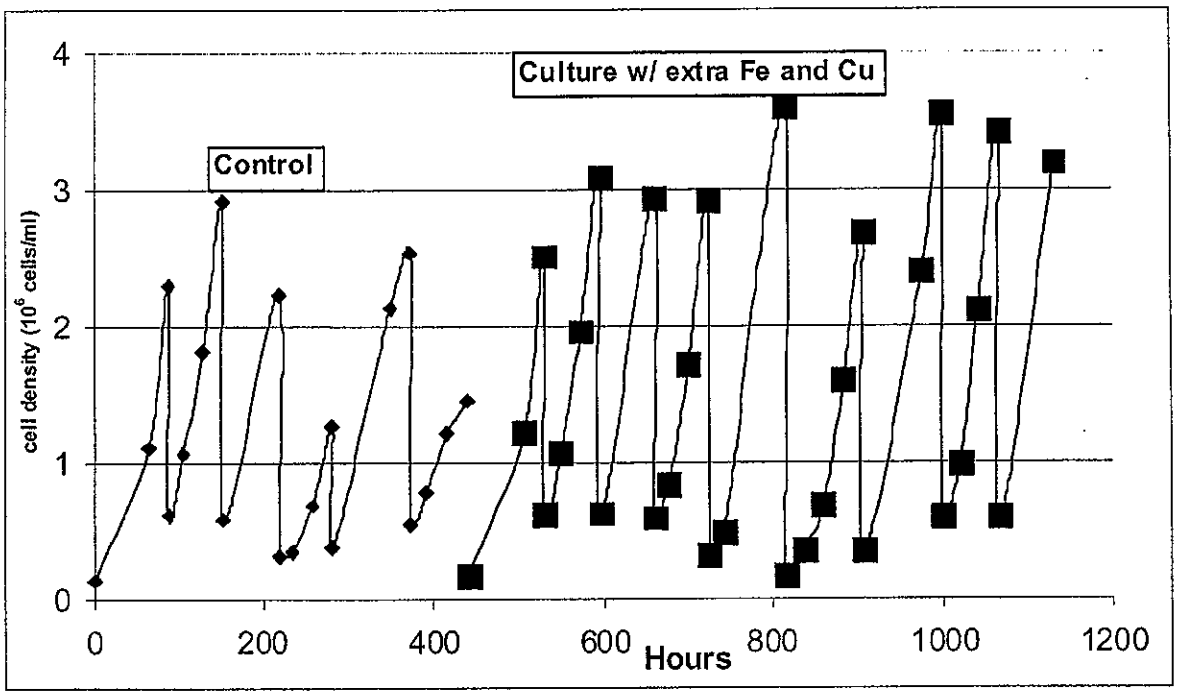

Culture w/ extra Fe and Cu
Control
cell density (10^6 cells/ml)
0
1
2
3
4
0
200
400
600
800
1000
1200
Hours

Figure 3

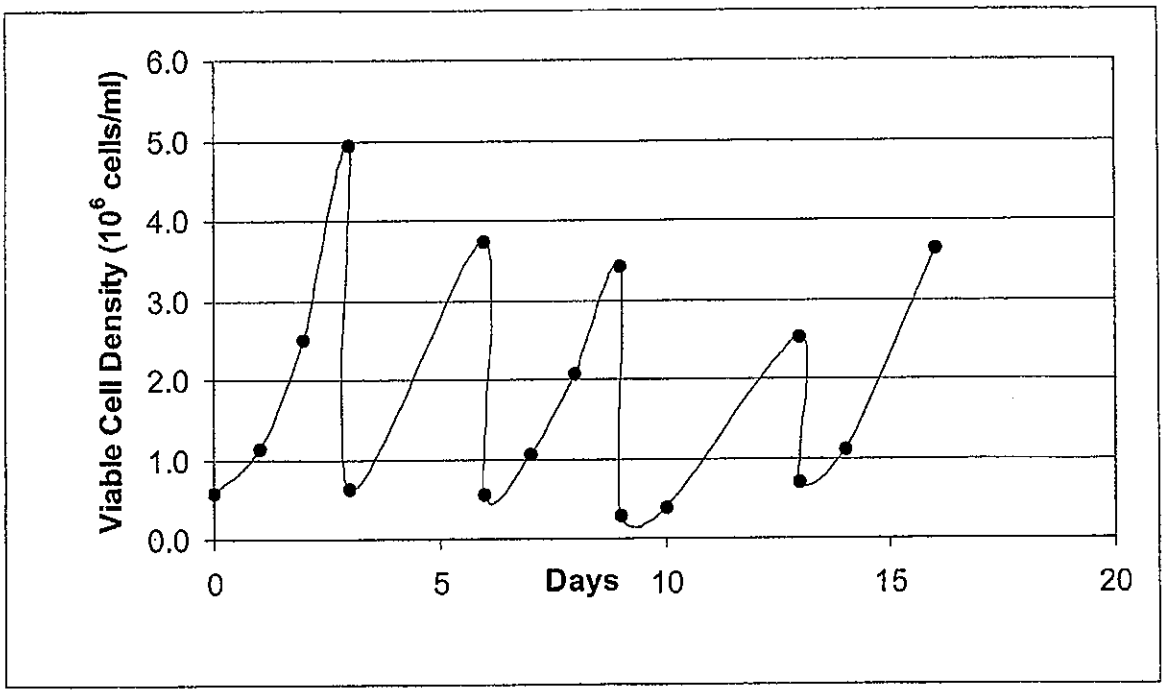

Viable Cell Density (10^6 cells/ml)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
5
Days
10
15
20

Figure 4

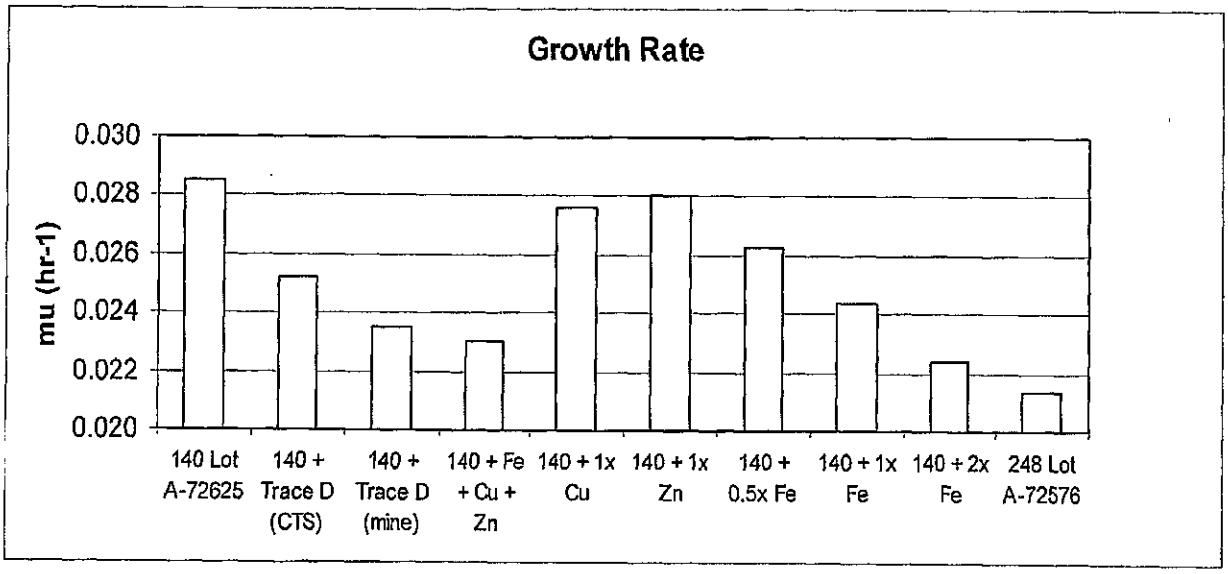

Growth Rate
mu (hr-1)
0.030
0.028
0.026
0.024
0.022
0.020
140 Lot A-72625
140 + Trace D (CTS)
140 + Trace D (mine)
140 + Fe + Cu + Zn
140 + 1x Cu
140 + 1x Zn
140 + 0.5x Fe
140 + 1x Fe
140 + 2x Fe
248 Lot A-72576

Figure 5

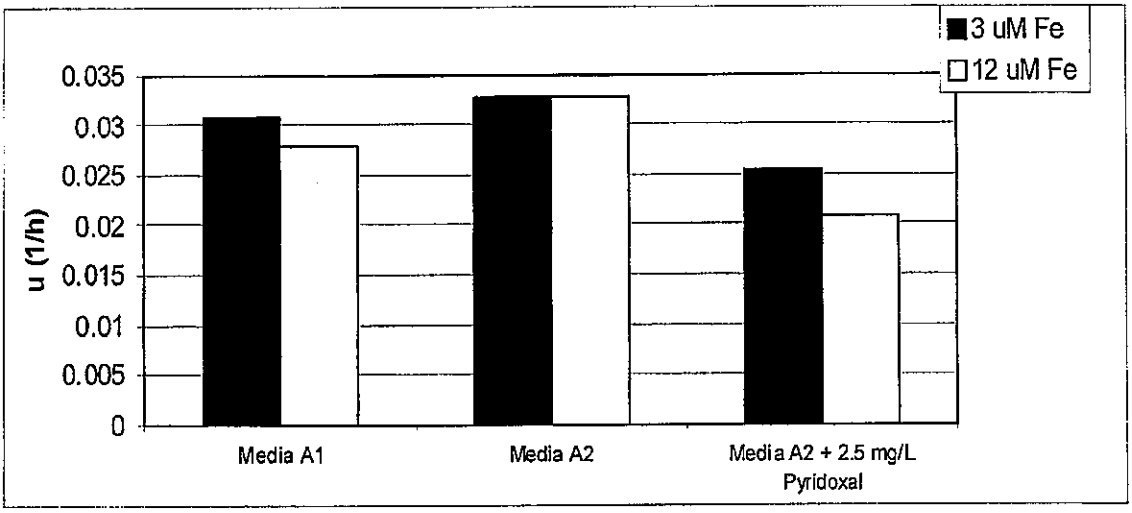

3 uM Fe
12 uM Fe
u (1/h)
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
Media A1
Media A2
Media A2 + 2.5 mg/L Pyridoxal

Figure 6

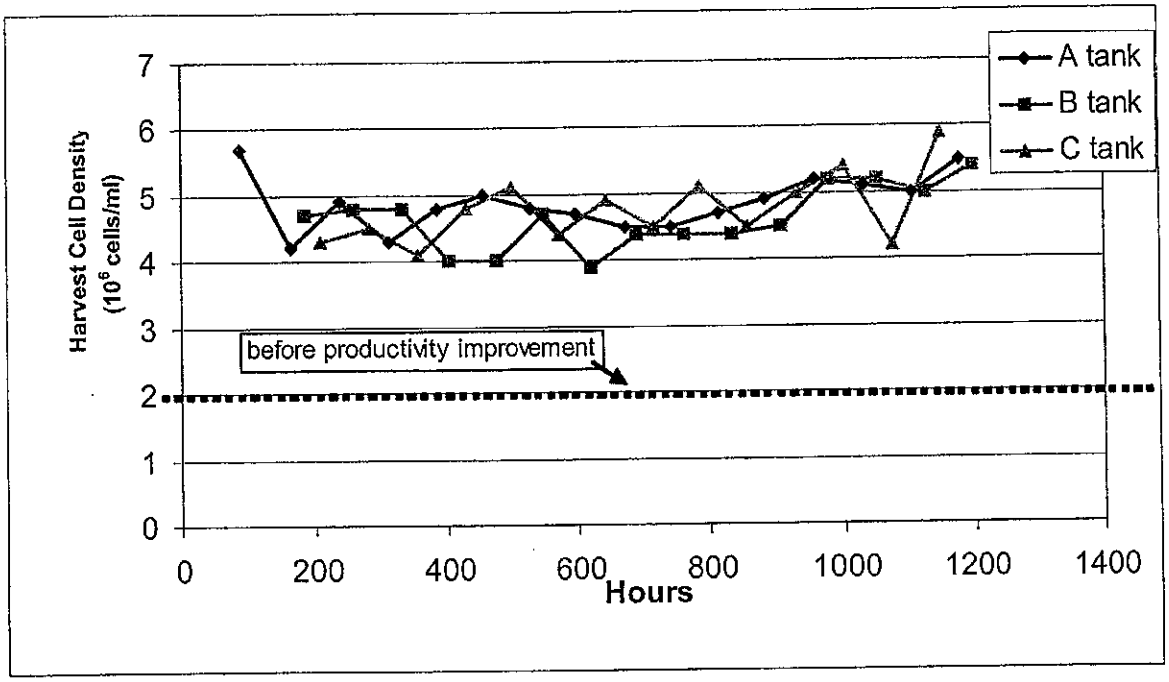
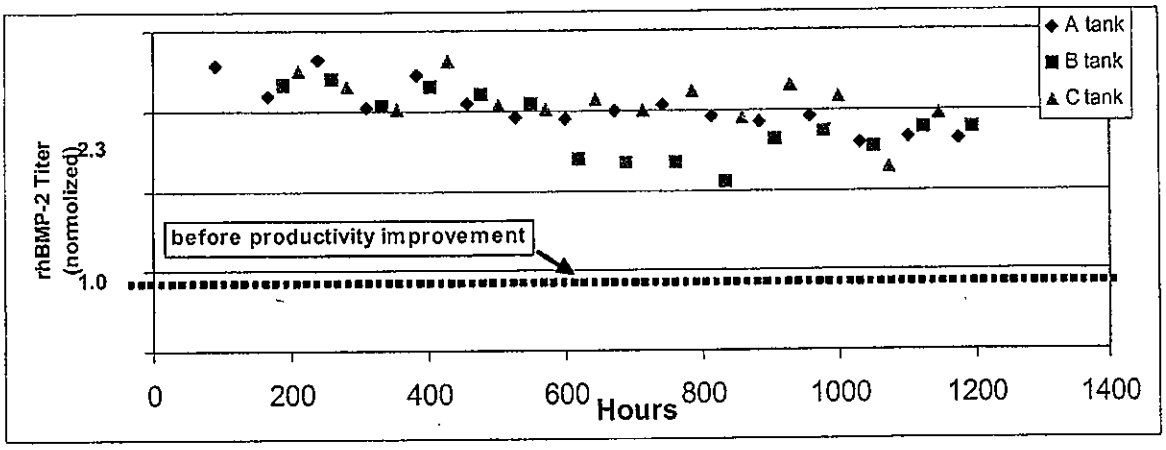

A tank
B tank
C tank
Harvest Cell Density (10^6 cells/ml)
7
6
5
4
3
2
1
0
before productivity improvement
0
200
400
600
800
1000
1200
1400
Hours

Figure 7


A tank
B tank
C tank
rhBMP-2 Titer (normolized)
2.3
1.0
before productivity improvement
0
200
400
600
800
1000
1200
1400
Hours