An Investigation of Methylsufonylmethane as a Fermentation Aid

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Abstract:

Fermentation time in the cellar directly affects potential brewery production as a whole. It is of practical interest to decrease time needed where possible and increase efficiency. Decreased lag time in beer fermentations allow for higher production and efficiency in the brewery as well as decreased risk of contamination. This study examined the use of methylsulfonylmethane (MSM) as a nutrient supplement to stimulate yeast growth during fermentation. Small-scale (1L), stirred fermentations were carried out at 15℃ using a German lager yeast in a lightly hopped 11℗ wort made from 70% pale 2-row malt and 30% high glucose liquid adjunct. Two pitching rates were examined, $1x10^6$ and $1x10^5$ cell/ml·℗, and four levels of MSM (0, 0.25, 0.5, and 075% w/w). Fermentation gravity and viable cell counts were monitored throughout fermentation until the final attenuation was achieved (approximately 5 days). The application of 0.25% w/w MSM resulted in the shortest lag time in both adequately ($1x10^6$ cell/ml·℗) and under-pitched ($1x10^5$ cell/ml·℗) ferments. Additionally, this treatment reached stable, maximum cell counts and final gravity the quickest. Increased concentrations of MSM trended with higher terminal gravities and lower fermentability irrespective of pitching rate. Application of MSM to beer fermentations has the potential to decreased lag time and increase peak rate in beer fermentations.

Methods:

Wort Production: 15 liters of wort (70% pale 2-row malt and 30% high glucose liquid adjunct) was prepared achieving a starting gravity of 11° Plato. Two hop additions of 13.96 g of Mt Hood hops were used at 55 minutes and 5 minutes of the 60 minute boil. The wort was chilled to 13℃ and oxygenated to appr oximately 17.75 ppm.

Pitching and application- A cell count and viability was performed according to ASBC methods to determine the pitching rate of White Labs German Lager yeast for 1000 ml ferments. Two series were used, one pitched to $1x10^6$ cell/ml·℗, which is a typical pitching rate for a commercial fermentation, the other to $1x10^5$ cell/ml·℗, which is a significantly underpitched level. Methylsulfonylmethane (MSM) was applied in .25% w/w increments between 0 and .75% w/w to each series. The flasks containing 1000 ml of wort, a correct yeast concentration, and corresponding MSM addition were placed on stir plates, with stir bars, for the duration of the fermentation in a room that was held at 15 ℃.

Fermentation and Data Collection- Ferments were kept anaerobic by cotton plugs inserted into the top of the flask. 2 ml aliquots were taken at each sampling point, one for cell counts, and one for ℗Brix measurements. Ce ll counts were performed according to ASBC methods. For ℗Brix measurements, 1 ml of s olution was placed in a 1 ml microtube and centrifuged for 8 minutes at 10,000 rpm before reading on the digital

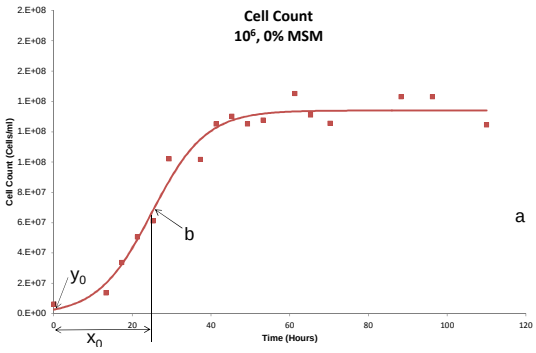
densitometer. Cell count and gravity measurements started 13.25 hours after the initial reading. From that point on data was collected every 4 hours, except for one 8 hr period at night, until the cell count was steady and/or terminal gravity achieved.

Data Analysis- Sigmaplot, scientific data and analysis software, was used to fit the data to a respresentative sigmoidal curve. The equation of the curve is seen below:

$$y_0 + \left[\frac{a}{1 + e^{-\frac{x - x_0}{b}}} \right]$$

Where y_0 respresents starting cell count or terminal gravity, *a* is maximum cell growth or fermentation, x_0 is the time peak rate of cell growth or peak rate of fermentation, and b is related to the slope of the curve.

Results:



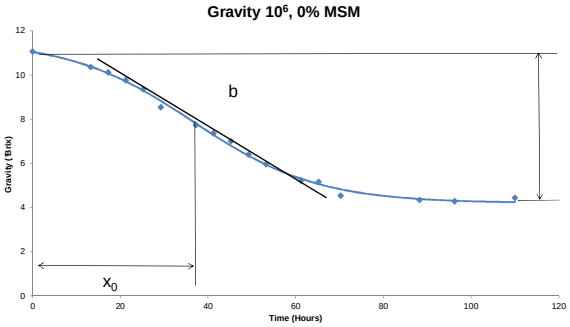


Table 1.1 Sigmoidal Curve Parameters of Gravity Data

Pitching rate	10^6	10^6	10^6	10^6	10^5	10^5	10^5	10^5
MSM level	0%	0.25%	0.5%	0.75%	0%	0.25%	0.5%	0.75%
Real Extract (a)	7.4	7.2	7.0	7.0	7.0	7.0	6.7	6.6
Fermentation Rate at Max (b)	-14.1	-11.4	-13.7	-14.1	-12.7	-10.6	-13.2	-13.2
Time to Max Fermentation Rate (x0)	36.7	28.4	38.1	36.5	47.9	33.1	45.9	54.7
Terminal Gravity (y0)	4.2	4.4	4.5	4.6	4.2	4.5	4.8	4.9

As expected time to max fermentation rate was shorter for the 10^6 cell/ml·℗ pitching rate, than in the 10^5 cell/ml·℗ pitching rate (Figure 1.1). The range of time to peak fermentation for the 10^6 cell/ml·℗ pitching rate was 28 - 38 hours while the range for the underpitched series was 33 - 55 hours.

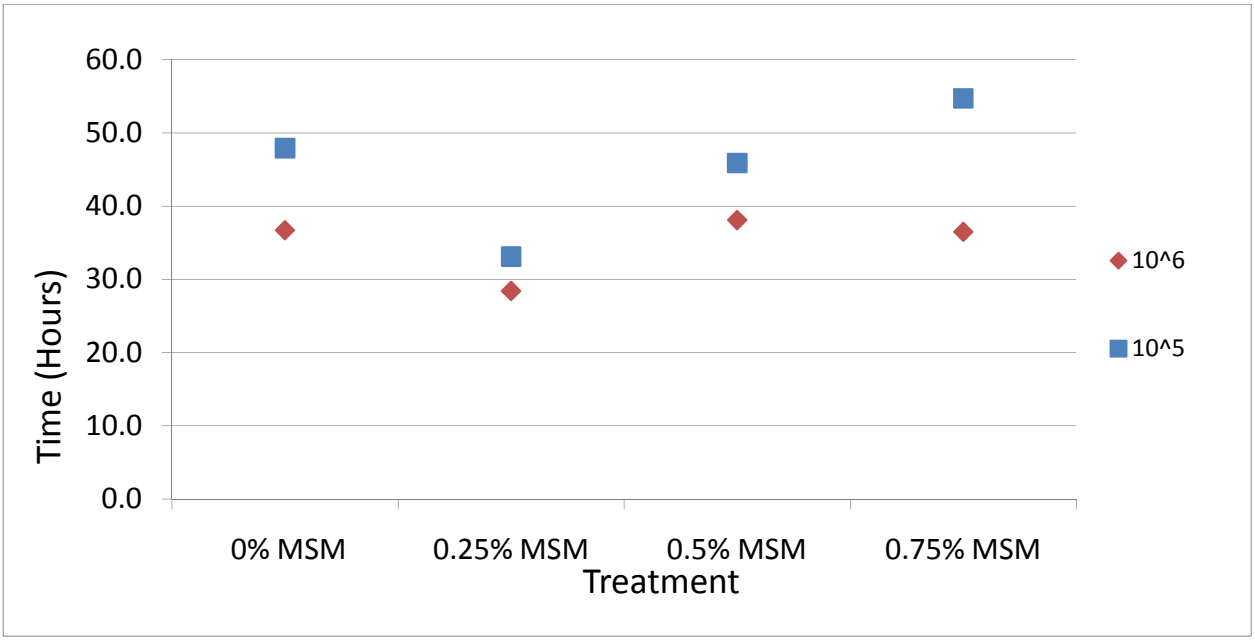


Figure 1.1Time to Max Fermentation (x_0)

Peak rate of fermentation, also showed a strong correlation to the addition of .25% w/w MSM, in both series; as seen in Figure 1.2.

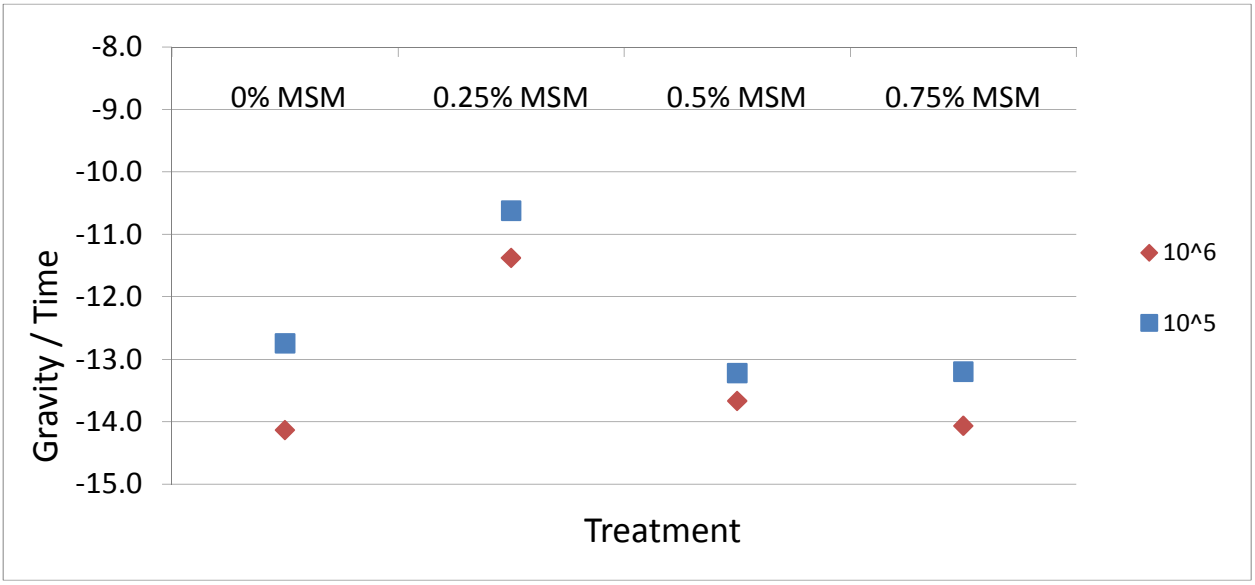


Figure 1.2 Rate of Fermentation at Max (1/b)

As expected the 10^6 cell/ml·℗ pitching rate showed lower terminal gravities as compared to the underpitched counterparts. Increased treatments of MSM also trend to higher terminal gravity in both series indicating a possible antagonistic effect on yeast health at the end of fermentation (Figure 1.3).

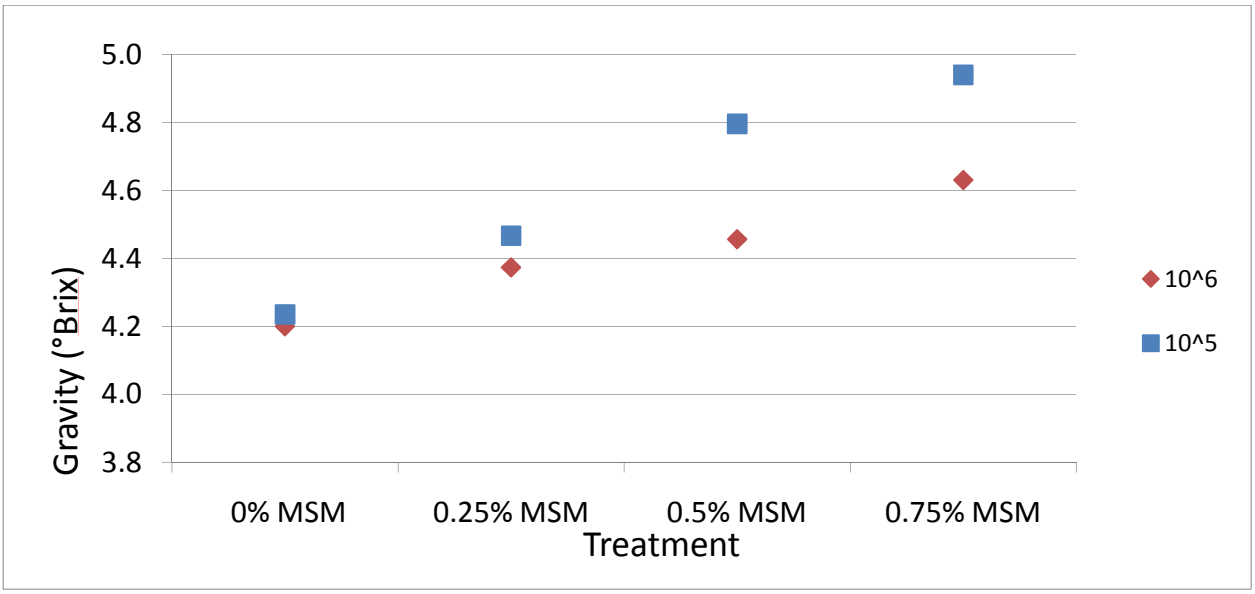


Figure 1.3 Terminal gravity (y_0)

Table 1.2 Sigmoidal Curve Paramters of Cell Count Data

Pitching rate	10^6	10^6	10^6	10^6	10^5	10^5	10^5	10^5
MSM level	0%	0.25%	0.5%	0.75%	0%	0.25%	0.5%	0.75%
Total Cell Growth (a)	1.3 x 10^8	1.3 x 10^8	1.5E+08	1.2E+08	1.1E+08	1.3E+08	1.2E+08	1.1E+08
Rate of Cell Growth (b)	6.85	3.52	6.42	4.38	6.50	2.99	8.53	8.43
Time to Max Cell Growth (x0)	24.91	19.62	24.28	23.54	32.74	22.87	32.09	39.28
Initial Cell Count (y0)	-9.2E+05	9.0E+06	4.5E+06	1.1E+07	2.9E+05	7.9E+06	-2.3E+06	-1.9E+06

As seen below, Figure 2.1, time to max cell growth and time to peak fermentation rate was shortest with the 0.25% MSM treatment.

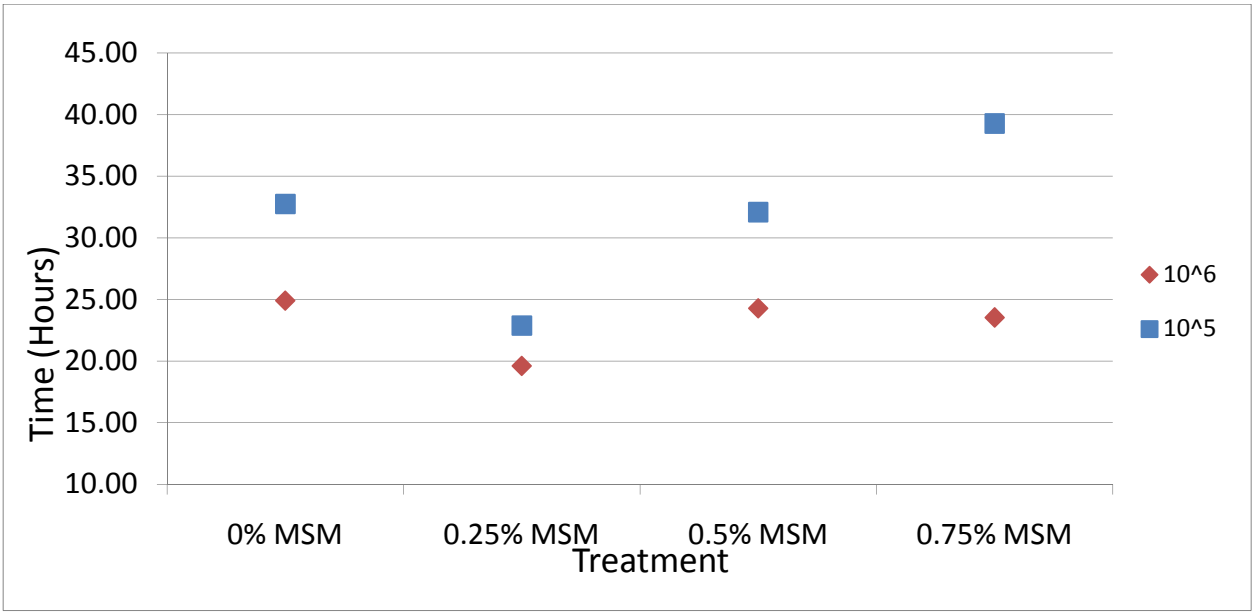


Figure 2.1 Time to Max Cell Growth

Increased treatments of MSM were shown to have a lower rate of cell growth in the 10^5 cell/ml·℗ pitching rate, though not in the 10^6 cell/ml·℗ pitching rate, as seen in Figure 2.2.

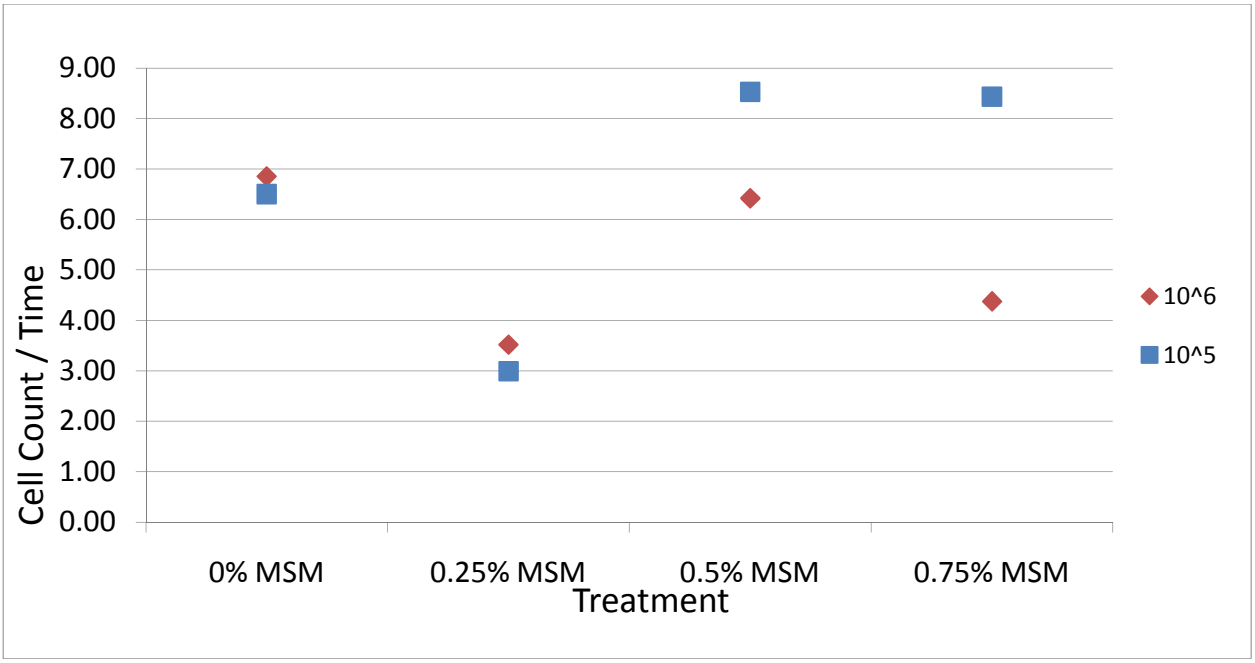


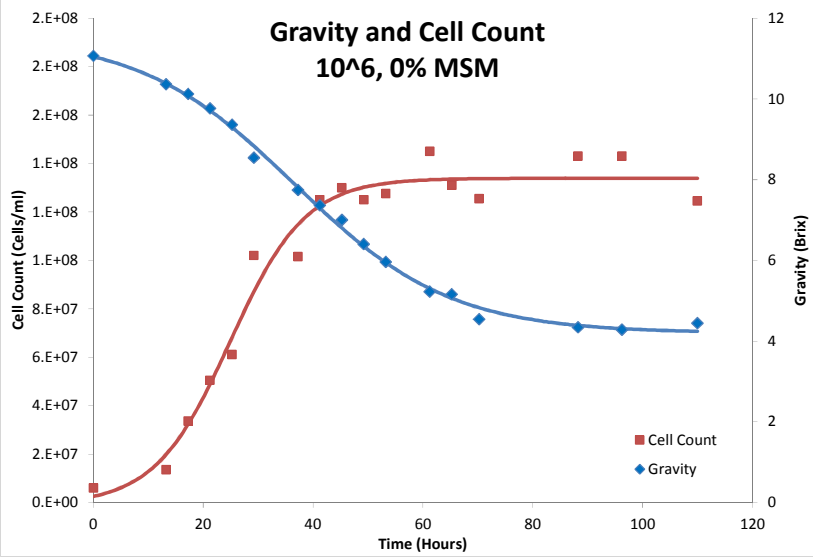
Figure 2.2 Rate of Cell Growth at Max (1/b)

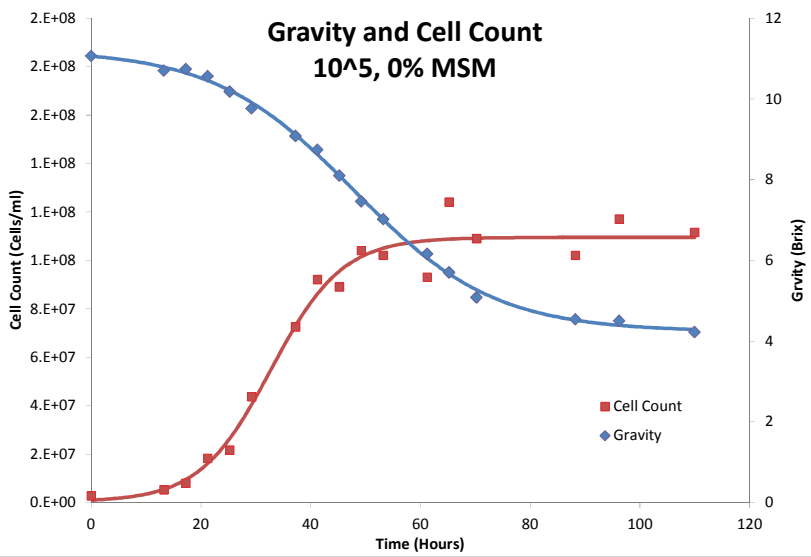
Conclusion:

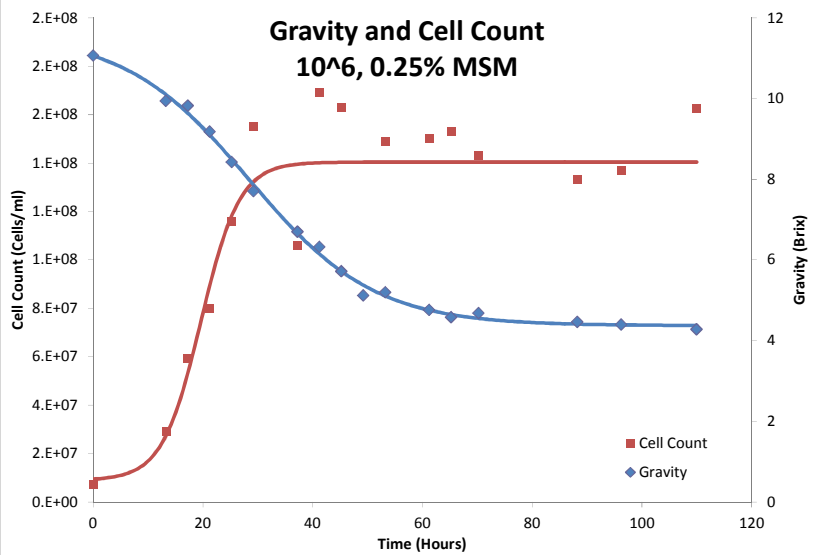
A strong correlation was seen between peak fermentation time and the addition of .25% w/w MSM, in both pitching rates. Decreased lag time was exhibited along with a faster

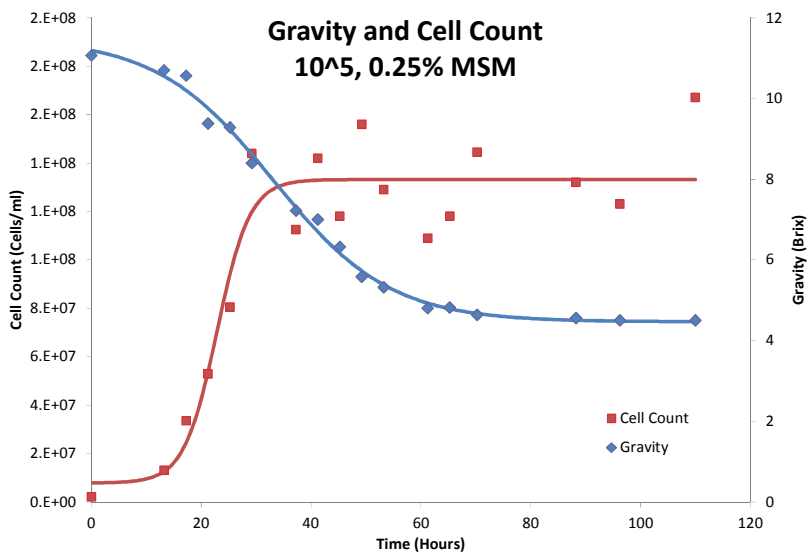
rate of fermentation in both 0.25% w/w additions. This trend was accompanied by a slight increase in residual extract with increased additions of MSM. As expected, the 10^6 cell/ml·℗ pitching rate had a higher total cell count, and faster rate of fermentation, than the 10^5 cell/ml·℗ pitching rate. Further analysis of treatments su rrounding the 0.25% w/w MSM treatment may show a stronger correlation to peak fermentation rate at higher or lower addition levels.

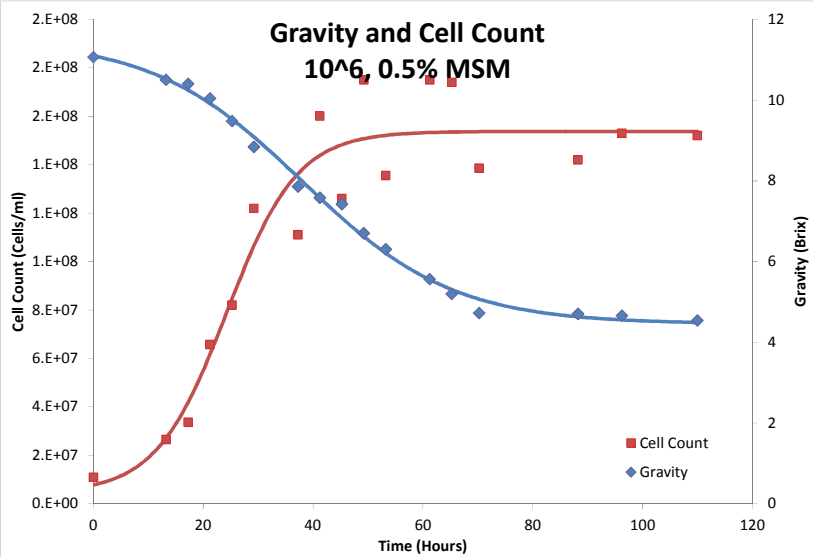
Appendix – Raw data and fitted performance curves for all treatments.







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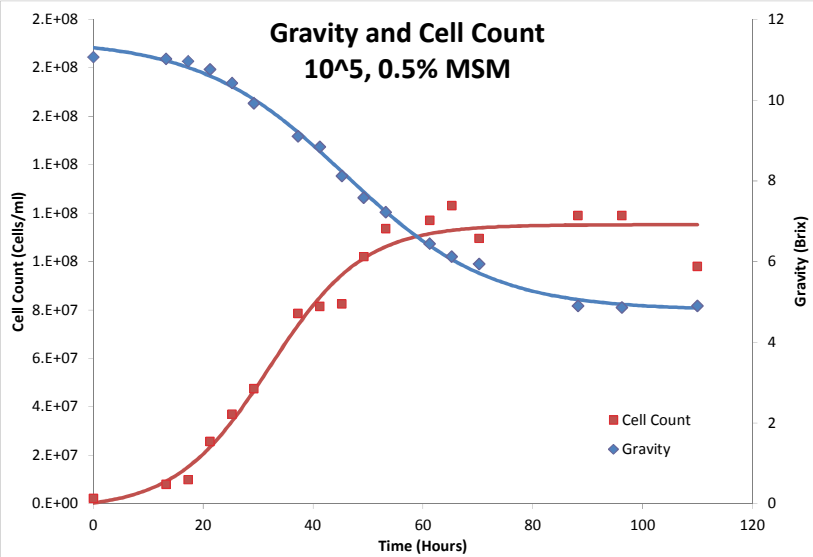
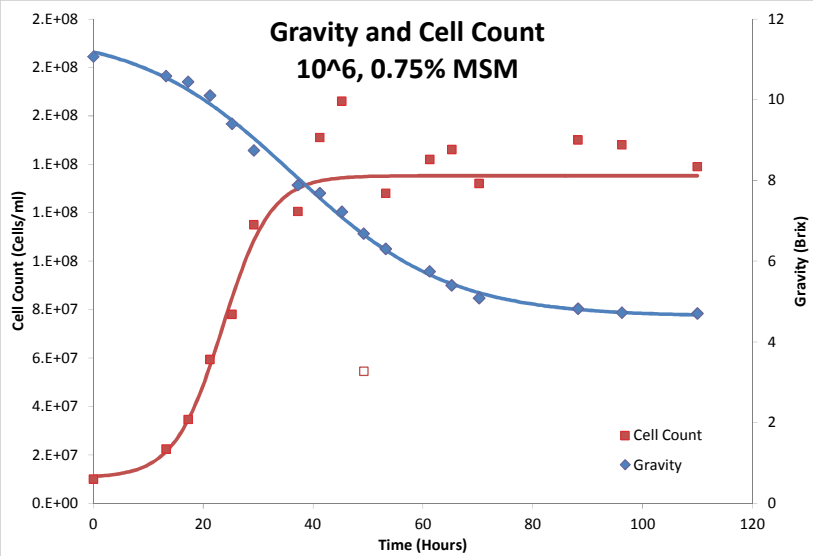
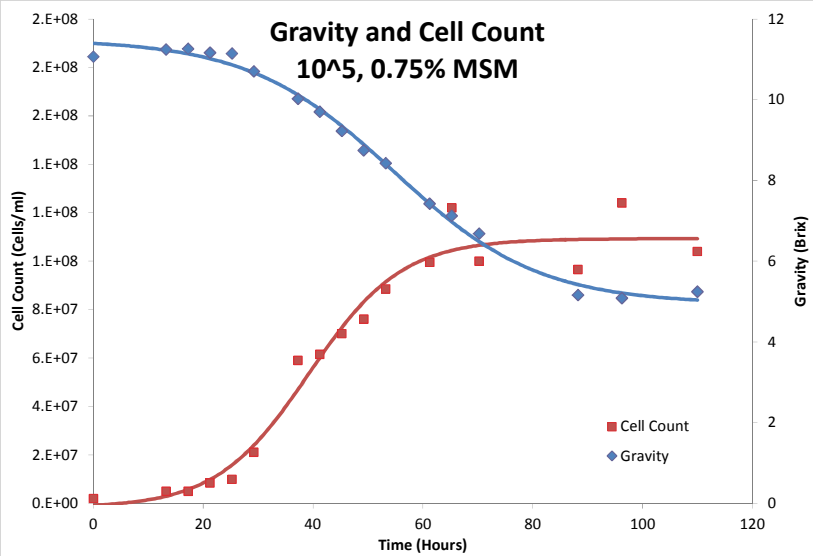
10^6, 0.5% MSM
Cell Count (Cells/ml)
Gravity (Brix)
Time (Hours)
Cell Count
Gravity


Gravity and Cell Count
10^5, 0.5% MSM
Cell Count (Cells/ml)
Gravity (Brix)
Time (Hours)
Cell Count
Gravity


Gravity and Cell Count
10^6, 0.75% MSM
Cell Count (Cells/ml)
Gravity (Brix)
Time (Hours)
Cell Count
Gravity


Gravity and Cell Count
10^5, 0.75% MSM
Cell Count (Cells/ml)
Gravity (Brix)
Time (Hours)
Cell Count
Gravity