

APÉNDICE 3: DETERMINACIÓN DEL NÚMERO TOTAL DE CÉLULAS EN LA CURVA DE CRECIMIENTO DE LA CEPA UDLAP-07 Y LA CEPA CM-05.

A continuación se muestran los resultados de los experimentos realizados. Se exponen tablas de resultados y gráficas que representan las curvas de crecimiento de la cepa pura y la cepa comercial, indicando el número total de células por mililitro de solución.

A. *Saccharomyces cerevisiae* cepa UDLAP-07

a) Sin tratamiento

Tiempo (hrs)	Absorbancia (nm)	#células/mL	Número células totales	log #cel/mL	Log Número cel Total
0	0.050	5.085	6.36E+06	0.706	6.803
2	0.123	25.402	3.18E+07	1.405	7.502
3	0.206	42.543	5.32E+07	1.629	7.726
4	0.222	45.848	5.73E+07	1.661	7.758
5	0.238	49.152	6.14E+07	1.692	7.788
6	0.289	59.685	7.46E+07	1.776	7.873
7	0.307	63.402	7.93E+07	1.802	7.899
9	0.341	70.424	8.80E+07	1.848	7.945
10	0.356	73.522	8.93E+07	1.866	7.963
11	0.379	78.272	9.78E+07	1.894	7.991
12	0.392	80.957	1.01E+08	1.908	8.005
13	0.411	84.880	1.06E+08	1.929	8.026
15	0.442	91.283	1.14E+08	1.960	8.057
18	0.457	94.380	1.18E+08	1.975	8.072
20	0.478	98.717	1.23E+08	1.994	8.091
22	0.488	100.783	1.26E+08	2.003	8.100
23	0.550	113.587	1.42E+08	2.055	8.152
24	0.519	107.185	1.34E+08	2.030	8.127
25	0.530	109.457	1.37E+08	2.039	8.136
28	0.540	111.522	1.39E+08	2.047	8.144
32	0.480	99.130	1.24E+08	1.996	8.093
36	0.441	91.076	1.14E+08	1.959	8.056
38	0.435	89.837	1.12E+08	1.953	8.050
40	0.435	89.837	1.12E+08	1.953	8.050
43	0.437	90.250	1.13E+08	1.955	8.052

Tabla 16. Relación entre la absorbancia y el número de células de *S. cerevisiae* cepa UDLAP-07 sin tratamiento.

b) Plomo

Tiempo (hrs)	5 ppm Pb			10 ppm Pb			15 ppm Pb		
	Absorbancia (nm)	#celulas/mL	Número cel total	Absorbancia (nm)	#celulas/mL	Número cel total	Absorbancia (nm)	#celulas/mL	Número cel total
0	0.050	5.085	6.36E+06	0.050	5.085	6.36E+06	0.050	5.085	6.36E+06
2	0.061	6.203	7.75E+06	0.063	6.407	8.01E+06	0.050	5.085	6.36E+06
3	0.068	6.915	8.64E+06	0.078	7.932	9.92E+06	0.050	5.085	6.36E+06
4	0.073	7.424	9.28E+06	0.077	7.831	9.79E+06	0.050	5.085	6.36E+06
5	0.072	7.322	9.15E+06	0.084	8.542	1.07E+07	0.052	5.288	6.61E+06
6	0.136	13.831	1.73E+07	0.109	11.085	1.39E+07	0.052	5.288	6.61E+06
7	0.167	16.983	2.12E+07	0.112	11.390	1.42E+07	0.052	5.288	6.61E+06
9	0.208	21.153	2.64E+07	0.135	13.729	1.72E+07	0.052	5.288	6.61E+06
10	0.215	21.864	2.73E+07	0.167	16.983	2.12E+07	0.053	5.390	6.74E+06
11	0.217	22.068	2.76E+07	0.159	16.169	2.02E+07	0.052	5.288	6.61E+06
12	0.221	22.475	2.81E+07	0.173	17.593	2.20E+07	0.051	5.186	6.48E+06
13	0.236	24.000	3.00E+07	0.174	17.695	2.21E+07	0.052	5.288	6.61E+06
15	0.249	25.322	3.17E+07	0.191	19.424	2.43E+07	0.052	5.288	6.61E+06
18	0.248	25.220	3.15E+07	0.214	21.763	2.72E+07	0.053	5.390	6.74E+06
20	0.315	32.034	4.00E+07	0.319	32.441	4.06E+07	0.052	5.288	6.61E+06
22	0.318	32.339	4.04E+07	0.321	32.644	4.08E+07	0.053	5.390	6.74E+06
23	0.331	33.661	4.21E+07	0.361	36.712	4.59E+07	0.052	5.288	6.61E+06
24	0.321	32.644	4.08E+07	0.366	37.220	4.65E+07	0.052	5.288	6.61E+06
25	0.328	33.356	4.17E+07	0.370	37.627	4.70E+07	0.054	5.492	6.86E+06
28	0.329	33.458	4.18E+07	0.368	37.424	4.68E+07	0.056	5.695	7.12E+06
32	0.327	33.254	4.16E+07	0.366	37.220	4.65E+07	0.056	5.695	7.12E+06
36	0.238	24.203	3.03E+07	0.222	22.576	2.82E+07	0.053	5.390	6.74E+06
38	0.229	23.288	2.91E+07	0.186	18.915	2.36E+07	0.051	5.186	6.48E+06
40	0.225	22.881	2.86E+07	0.183	18.610	2.33E+07	0.051	5.186	6.48E+06

Tabla 17. Relación entre la absorbancia y el número de células de *S. cerevisie* cepa UDLAP-07 en presencia de diferentes concentraciones de plomo.

Tiempo (hrs)	5 ppm	10 ppm	15 ppm
	log Número cel Total	log Número cel Total	log Número cel Total
0	6,803	6,803	6,803
2	6,890	6,904	6,803
3	6,937	6,996	6,803
4	6,968	6,991	6,803
5	6,962	7,028	6,820
6	7,238	7,142	6,820
7	7,327	7,153	6,820
9	7,422	7,235	6,820
10	7,437	7,327	6,828
11	7,441	7,306	6,820
12	7,449	7,342	6,812
13	7,477	7,345	6,820
15	7,500	7,385	6,820
18	7,499	7,435	6,828
20	7,603	7,608	6,820
22	7,607	7,611	6,828
23	7,624	7,662	6,820

24	7,611	7,668	6,820
25	7,620	7,672	6,837
28	7,621	7,670	6,852
32	7,619	7,668	6,852
36	7,481	7,451	6,828
38	7,464	7,374	6,812
40	7,456	7,367	6,812

Tabla 18. Logaritmo del número total de células de *S. cerevisiae* cepa UDLAP-07 en presencia de diferentes concentraciones de plomo.

c) Cadmio

Tiempo (hrs)	5 ppm Cd			10 ppm Cd			15 ppm Cd		
	Absorbancia (nm)	#celulas/mL	Número cel total	Absorbancia (nm)	#celulas/mL	Número cel total	Absorbancia (nm)	#celulas/mL	Número cel total
0	0.050	5.085	6.36E+06	0.050	5.085	6.36E+06	0.050	5.085	6.36E+06
2	0.098	9.966	1.25E+07	0.055	5.593	6.99E+06	0.050	5.085	6.36E+06
3	0.104	10.576	1.32E+07	0.083	8.441	1.06E+07	0.051	5.186	6.48E+06
4	0.113	11.492	1.44E+07	0.104	10.576	1.32E+07	0.051	5.186	6.48E+06
5	0.116	11.797	1.47E+07	0.115	11.695	1.46E+07	0.050	5.085	6.36E+06
6	0.129	13.119	1.64E+07	0.132	13.424	1.68E+07	0.051	5.186	6.48E+06
7	0.205	20.847	2.61E+07	0.154	15.661	1.96E+07	0.052	5.288	6.61E+06
9	0.213	21.661	2.71E+07	0.169	17.186	2.15E+07	0.054	5.492	6.86E+06
10	0.224	22.780	2.85E+07	0.203	20.644	2.58E+07	0.051	5.186	6.48E+06
11	0.232	23.593	2.95E+07	0.215	21.864	2.73E+07	0.052	5.288	6.61E+06
12	0.281	28.576	3.57E+07	0.244	24.814	3.10E+07	0.052	5.288	6.61E+06
13	0.299	30.407	3.80E+07	0.258	26.237	3.28E+07	0.053	5.390	6.74E+06
15	0.378	38.441	4.81E+07	0.312	31.729	3.97E+07	0.053	5.390	6.74E+06
18	0.367	37.322	4.67E+07	0.345	35.085	4.39E+07	0.053	5.390	6.74E+06
20	0.371	37.729	4.72E+07	0.351	35.695	4.46E+07	0.052	5.288	6.61E+06
22	0.449	45.661	5.71E+07	0.402	40.881	5.11E+07	0.054	5.492	6.86E+06
23	0.457	46.475	5.81E+07	0.413	42.000	5.25E+07	0.057	5.797	7.25E+06
24	0.478	48.610	6.08E+07	0.417	42.407	5.30E+07	0.058	5.898	7.37E+06
25	0.478	48.610	6.08E+07	0.418	42.508	5.31E+07	0.058	5.898	7.37E+06
28	0.477	48.508	6.06E+07	0.417	42.407	5.30E+07	0.057	5.797	7.25E+06
32	0.389	39.559	4.94E+07	0.357	36.305	4.54E+07	0.054	5.492	6.86E+06
36	0.321	32.644	4.08E+07	0.316	32.136	4.02E+07	0.054	5.492	6.86E+06
38	0.312	31.729	3.97E+07	0.307	31.220	3.90E+07	0.052	5.288	6.61E+06
40	0.318	32.339	4.04E+07	0.303	30.814	3.85E+07	0.051	5.186	6.48E+06

Tabla 19. Relación entre la absorbancia y el número de células de *S. cerevisiae* cepa UDLAP-07 en presencia de diferentes concentraciones de cadmio.

Tiempo (hrs)	5 ppm	10 ppm	15 ppm
	log Número cel Total	log Número cel Total	log Número cel Total
0	6,803	6,803	6,803
2	7,095	6,845	6,803
3	7,121	7,023	6,812
4	7,157	7,121	6,812
5	7,169	7,165	6,803
6	7,215	7,225	6,812

7	7,416	7,292	6,820
9	7,433	7,332	6,837
10	7,454	7,412	6,812
11	7,470	7,437	6,820
12	7,553	7,492	6,820
13	7,580	7,516	6,828
15	7,682	7,598	6,828
18	7,669	7,642	6,828
20	7,674	7,650	6,820
22	7,756	7,708	6,837
23	7,764	7,720	6,860
24	7,784	7,724	6,868
25	7,784	7,725	6,868
28	7,783	7,724	6,860
32	7,694	7,657	6,837
36	7,611	7,604	6,837
38	7,598	7,591	6,820
40	7,607	7,586	6,812

Tabla 20. Logaritmo del número total de células de *S. cerevisiae* cepa UDLAP-07 en presencia de diferentes concentraciones de cadmio.

B. *Saccharomyces cerevisiae* cepa CM-05 sin tratamiento

a) Sin tratamiento

Tiempo (hrs)	Absorbancia (nm)	#células/mL	Número de células totales	log #cel/mL	Log Número cel Total
0	0.05	5.085	6.36E+06	0.706	6.803
2	0.163	33.663	4.21E+07	1.527	7.624
3	0.179	36.967	4.62E+07	1.568	7.665
4	0.282	58.239	7.28E+07	1.765	7.862
5	0.465	96.033	1.20E+08	1.982	8.079
7	0.48	99.130	1.24E+08	1.996	8.093
9	0.576	118.957	1.49E+08	2.075	8.172
10	0.599	123.707	1.55E+08	2.092	8.189
11	0.603	124.533	1.56E+08	2.095	8.192
12	0.628	129.696	1.62E+08	2.113	8.210
13	0.652	134.652	1.68E+08	2.129	8.226
15	0.68	140.435	1.76E+08	2.147	8.244
18	0.714	147.457	1.84E+08	2.169	8.266
20	0.748	154.478	1.93E+08	2.189	8.286
22	0.764	157.783	1.97E+08	2.198	8.295
23	0.795	164.185	2.05E+08	2.215	8.312
24	0.796	164.391	2.05E+08	2.216	8.313
25	0.795	164.185	2.05E+08	2.215	8.312
28	0.798	164.804	2.06E+08	2.217	8.314
32	0.795	164.185	2.05E+08	2.215	8.312
36	0.707	146.011	1.83E+08	2.164	8.261
38	0.558	115.239	1.44E+08	2.062	8.159
40	0.438	90.457	1.13E+08	1.956	8.053
42	0.436	90.043	1.13E+08	1.954	8.051
43	0.437	90.250	1.13E+08	1.955	8.052

Tabla 21. Relación entre la absorbancia y el número de células de *S. cerevisiae* cepa CM-05 sin tratamiento.

b) Plomo

Tiempo (hrs)	5 ppm Pb			10 ppm Pb			15 ppm Pb		
	Absorbancia (nm)	#celulas/mL	Número cel total	Absorbancia (nm)	#celulas/mL	Número cel total	Absorbancia (nm)	#celulas/mL	Número cel total
0	0.050	5.085	6.36E+06	0.050	5.085	6.36E+06	0.050	5.085	6.36E+06
2	0.072	7.322	9.15E+06	0.057	5.797	7.25E+06	0.050	5.085	6.36E+06
3	0.091	9.254	1.16E+07	0.085	8.644	1.08E+07	0.053	5.390	6.74E+06
4	0.108	10.983	1.37E+07	0.112	11.390	1.42E+07	0.050	5.085	6.36E+06
5	0.165	16.780	2.10E+07	0.129	13.119	1.64E+07	0.052	5.288	6.61E+06
7	0.187	19.017	2.38E+07	0.144	14.644	1.83E+07	0.050	5.085	6.36E+06
9	0.174	17.695	2.21E+07	0.169	17.186	2.15E+07	0.052	5.288	6.61E+06
10	0.193	19.627	2.45E+07	0.172	17.492	2.19E+07	0.050	5.085	6.36E+06
11	0.204	20.746	2.59E+07	0.187	19.017	2.38E+07	0.053	5.390	6.74E+06
12	0.238	24.203	3.03E+07	0.208	21.153	2.64E+07	0.052	5.288	6.61E+06
13	0.237	24.102	3.01E+07	0.225	22.881	2.86E+07	0.050	5.085	6.36E+06
15	0.269	27.356	3.42E+07	0.273	27.763	3.47E+07	0.052	5.288	6.61E+06
18	0.295	30.000	3.75E+07	0.281	28.576	3.57E+07	0.052	5.288	6.61E+06
20	0.315	32.034	4.00E+07	0.319	32.441	4.06E+07	0.050	5.085	6.36E+06
22	0.386	39.254	4.91E+07	0.352	35.797	4.47E+07	0.052	5.288	6.61E+06
23	0.450	45.763	5.72E+07	0.385	39.153	4.89E+07	0.051	5.186	6.48E+06
24	0.463	47.085	5.89E+07	0.398	40.475	5.06E+07	0.056	5.695	7.12E+06
25	0.486	49.424	6.18E+07	0.405	41.186	5.15E+07	0.058	5.898	7.37E+06
28	0.485	49.322	6.17E+07	0.406	41.288	5.16E+07	0.058	5.898	7.37E+06
32	0.484	49.220	6.15E+07	0.403	40.983	5.12E+07	0.058	5.898	7.37E+06
36	0.432	43.932	5.49E+07	0.392	39.864	4.98E+07	0.056	5.695	7.12E+06
38	0.419	42.610	5.33E+07	0.377	38.339	4.79E+07	0.055	5.593	6.99E+06
40	0.402	40.881	5.11E+07	0.341	34.678	4.33E+07	0.051	5.186	6.48E+06
42	0.357	36.305	4.54E+07	0.339	34.475	4.31E+07	0.050	5.085	6.36E+06
43	0.351	35.695	4.46E+07	0.324	32.949	4.12E+07	0.051	5.186	6.48E+06

Tabla 22. Relación entre la absorbancia y el número de células de *S. cerevisiae* cepa CM-05 en presencia de diferentes concentraciones de plomo.

Tiempo (hrs)	5 ppm	10 ppm	15 ppm
	log Número cel Total	log Número cel Total	log Número cel Total
0	6,803	6,803	6,803
2	6,962	6,860	6,803
3	7,063	7,034	6,828
4	7,138	7,153	6,803
5	7,322	7,215	6,820
7	7,376	7,263	6,803
9	7,345	7,332	6,820
10	7,390	7,340	6,803
11	7,414	7,376	6,828
12	7,481	7,422	6,820
13	7,479	7,456	6,803
15	7,534	7,540	6,820
18	7,574	7,553	6,820
20	7,603	7,608	6,803
22	7,691	7,651	6,820
23	7,757	7,690	6,812
24	7,770	7,704	6,852

25	7,791	7,712	6,868
28	7,790	7,713	6,868
32	7,789	7,710	6,868
36	7,740	7,697	6,852
38	7,726	7,681	6,845
40	7,708	7,637	6,812
42	7,657	7,634	6,803
43	7,650	7,615	6,812

Tabla 23. Logaritmo del número total de células de *S. cerevisie* cepa CM-05 en presencia de diferentes concentraciones de plomo

c) Cadmio

Tiempo (hrs)	5 ppm Cd			10 ppm Cd			15 ppm Cd		
	Absorbancia (nm)	#celulas/mL	Número cel total	Absorbancia (nm)	#celulas/mL	Número cel total	Absorbancia (nm)	#celulas/mL	Número cel total
0	0.050	10.326	1.29E+07	0.050	5.085	6.36E+06	0.050	10.326	1.29E+07
2	0.078	16.109	2.01E+07	0.055	5.593	6.99E+06	0.050	10.326	1.29E+07
3	0.101	20.859	2.61E+07	0.083	8.441	1.06E+07	0.050	10.326	1.29E+07
4	0.129	26.641	3.33E+07	0.104	10.576	1.32E+07	0.050	10.326	1.29E+07
5	0.156	32.217	4.03E+07	0.115	11.695	1.46E+07	0.050	10.326	1.29E+07
7	0.174	35.935	4.49E+07	0.132	13.424	1.68E+07	0.051	10.533	1.32E+07
9	0.205	42.337	5.29E+07	0.154	15.661	1.96E+07	0.051	10.533	1.32E+07
10	0.234	48.326	6.04E+07	0.189	19.220	2.40E+07	0.050	10.326	1.29E+07
11	0.241	49.772	6.22E+07	0.203	20.644	2.58E+07	0.051	10.533	1.32E+07
12	0.254	52.457	6.56E+07	0.215	21.864	2.73E+07	0.050	10.326	1.29E+07
13	0.281	58.033	7.25E+07	0.224	22.780	2.85E+07	0.052	10.739	1.34E+07
15	0.302	62.370	7.80E+07	0.238	24.203	3.03E+07	0.050	10.326	1.29E+07
18	0.318	65.674	8.21E+07	0.242	24.610	3.08E+07	0.053	10.946	1.37E+07
20	0.321	66.293	8.29E+07	0.245	24.915	3.11E+07	0.055	11.359	1.42E+07
22	0.326	67.326	8.42E+07	0.242	24.610	3.08E+07	0.055	11.359	1.42E+07
23	0.335	69.185	8.65E+07	0.242	24.610	3.08E+07	0.056	11.565	1.45E+07
24	0.359	74.141	9.27E+07	0.257	26.136	3.27E+07	0.057	11.772	1.47E+07
25	0.371	76.620	9.58E+07	0.264	26.847	3.36E+07	0.058	11.978	1.50E+07
28	0.368	76.000	9.50E+07	0.265	26.949	3.37E+07	0.057	11.772	1.47E+07
32	0.370	76.413	9.55E+07	0.264	26.847	3.36E+07	0.058	11.978	1.50E+07
36	0.353	72.902	9.11E+07	0.257	26.136	3.27E+07	0.056	11.565	1.45E+07
38	0.321	66.293	8.29E+07	0.226	22.983	2.87E+07	0.056	11.565	1.45E+07
40	0.307	63.402	7.93E+07	0.217	22.068	2.76E+07	0.052	10.739	1.34E+07
42	0.285	58.859	7.36E+07	0.213	21.661	2.71E+07	0.051	10.533	1.32E+07
43	0.279	57.620	7.20E+07	0.215	21.864	2.73E+07	0.050	10.326	1.29E+07

Tabla 24. Relación entre la absorbancia y el número de células de *S. cerevisie* cepa CM-05 en presencia de diferentes concentraciones de cadmio.

Tiempo (hrs)	5 ppm	10 ppm	15 ppm
	log Número cel Total	log Número cel Total	log Número cel Total
0	7,111	6,803	7,111
2	7,304	6,845	7,111
3	7,416	7,023	7,111
4	7,522	7,121	7,111
5	7,605	7,165	7,111
7	7,652	7,225	7,119
9	7,724	7,292	7,119
10	7,781	7,381	7,111
11	7,794	7,412	7,119
12	7,817	7,437	7,111
13	7,861	7,454	7,128
15	7,892	7,481	7,111
18	7,914	7,488	7,136
20	7,918	7,493	7,152
22	7,925	7,488	7,152
23	7,937	7,488	7,160
24	7,967	7,514	7,168
25	7,981	7,526	7,175
28	7,978	7,527	7,168
32	7,980	7,526	7,175
36	7,960	7,514	7,160
38	7,918	7,458	7,160
40	7,899	7,441	7,128
42	7,867	7,433	7,119
43	7,857	7,437	7,111

Tabla 25. Logaritmo del número total de células de *S. cerevisie* cepa CM-05 en presencia de diferentes concentraciones de cadmio.