

## Supplementary Information

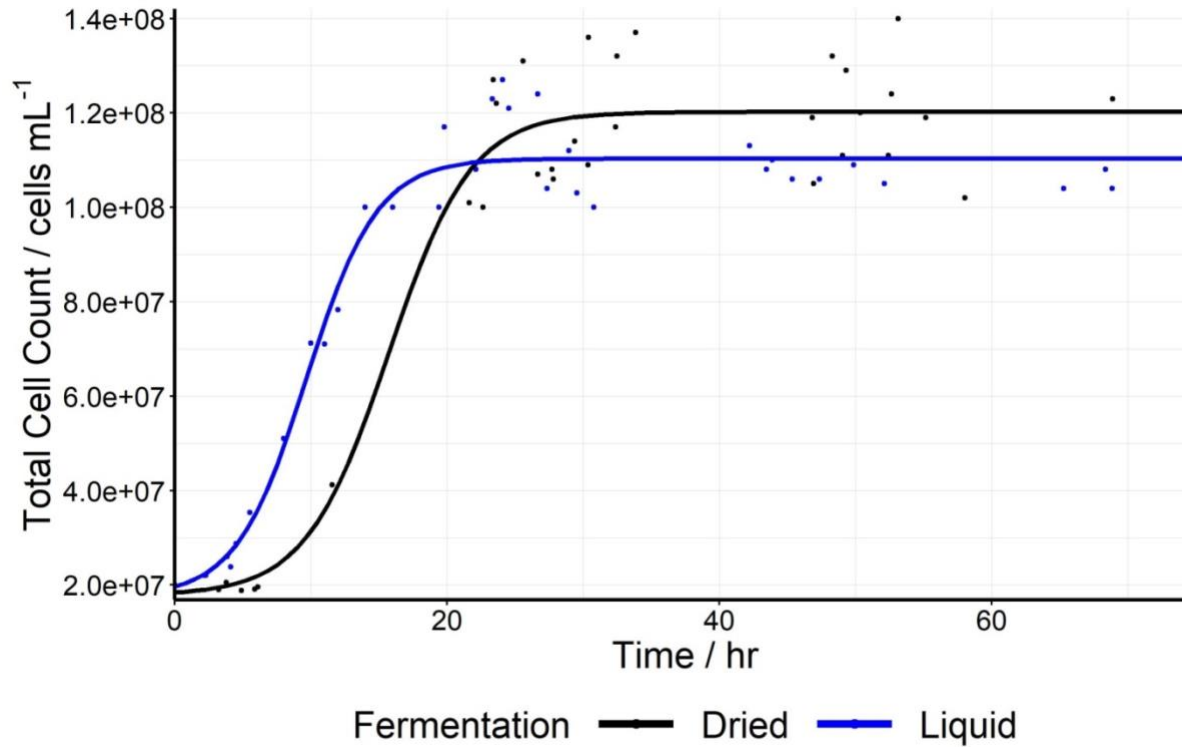
Supplementary 1 – Individual and combined model parameter outputs with respect to apparent extract decline during fermentation, values derived from model output and fermentation metrics for all fermentations discussed in this study.

Ferm. ID	Format	Pitch rate name	Pitch rate	n	Pi (°P)	Pe (°P)	B (/hr)	M (hr)	V <sub>max</sub> (°P/hr)	Lag time (hr)	EoF (hr)	Wash OG	Wash FG	Wash ABV (%v/v)
<b>DRIED YEAST</b>														
DYC1	Dried	Control	1.0g/L	14	15.9±0.3	-0.05±0.27	0.227±0.025	23.5±0.5	-0.90	14.7	48.7	1.0646	1.0020	8.09
DYC2				11	15.6±0.5	-0.11±0.31	0.330±0.048	27.1±0.4	-1.30	21.0	51.3	1.0646	1.0028	8.69
DYC3				13	15.7±0.4	-0.51±0.26	0.233±0.030	28.6±0.4	-0.95	20.0	45.0	1.0668	1.0001	8.92
DYU1		Underpitched	0.5g/L	14	16.2±0.5	-0.14±0.49	0.231±0.039	25.6±0.7	-0.94	17.0	53.4	1.0658	0.9989	8.62
DYU2				12	15.5±0.4	-0.06±0.22	0.316±0.055	29.7±0.5	-1.23	23.4	51.6	1.0631	0.9980	8.54
DYU3				12	15.5±0.5	-0.61±0.60	0.187±0.039	34.6±1.2	-0.75	23.9	49.6	1.0648	0.9989	8.88
DYO1		Overpitched	2.0g/L	14	16.3±0.7	-0.03±0.41	0.247±0.048	20.1±1.2	-1.01	12.0	42.5	1.0651	0.9987	8.32
DYO2				12	15.5±0.6	-0.17±0.30	0.254±0.056	21.4±0.8	-0.99	13.5	43.3	1.0632	0.9987	8.36
DYO3				12	15.9±0.7	-0.58±0.38	0.171±0.037	23.7±1.3	-0.71	12.0	48.4	1.0642	0.9987	8.80
<b>DRIED YEAST COMBINED</b>														
DYC	Dried	Control	1.0g/L	38	15.8 ±0.6	-0.21±0.47	0.211±0.042	29.4±0.8	-0.84±0.22	19.9±3.41	48.7±3.19	1.0653±0.0013	1.0016±0.0014	8.57±0.43
DYU		Underpitched	0.5g/L	38	15.7±0.4	-0.24±0.28	0.251±0.029	26.5±0.4	-1.00±0.24	18.5±3.87	51.3±1.87	1.0646±0.0014	0.9986±0.0005	8.68±0.18
DYO		Overpitched	2.0g/L	38	16.2±0.4	-0.25±0.20	0.201±0.022	21.0±0.7	-0.82±0.17	11.1±0.89	45.0±3.20	1.0637±0.0007	0.9987±0.0000	8.58±0.31

Supplementary 1 (contd) -Individual and combined model parameter outputs with respect to apparent extract decline during fermentation, values derived from model output and fermentation metrics for all fermentations discussed in this study.

Ferm. ID	Format	Pitch rate name	Pitch rate (cells/mL)	n	Pi (°P)	Pe (°P)	B (/hr)	M (hr)	V <sub>max</sub> (°P/hr)	Lag time (hr)	EoF (hr)	Wash OG	Wash FG	Wash ABV (%v/v)
<b>LIQUID YEAST</b>														
LYC1	Liquid	Control	2 x10 <sup>7</sup>	14	16.9±0.9	-0.61±0.27	0.207±0.040	16.8±1.7	-0.90	7.1	40.9	1.0657	0.99717	8.84
LYC2				11	17.3±0.9	-0.47±0.21	0.176±0.029	16.1±1.3	-0.78	4.7	44.4	1.0656	0.99911	8.70
LYC3				9	16.6±0.6	-0.57±0.32	0.186±0.032	19.2±0.9	-0.80	8.5	39.0	1.0655	0.99842	8.93
LYU41		Most underpitched	4 x10 <sup>4</sup>	12	18.3±1.5	0.98±0.77	0.065±0.012	38.4±3.2	-0.28	17.6	71.9	1.0686	1.00369	8.31
LYU42				16	17.5±1.2	2.21±0.84	0.085±0.022	41.0±2.5	-0.33	17.5	73.6	1.0670	1.00727	8.88
LYU43				14	17.4±0.8	1.66±0.66	0.082±0.015	46.0±2.1	-0.32	21.5	75.1	1.0683	1.00416	8.17
LYU31		Very underpitched	2 x10 <sup>5</sup>	12	22.2±1.3	0.44±0.25	0.054±0.004	20.5±2.2	-0.30	16.3	64.3	1.0687	1.0020	8.42
LYU32				16	18.0±0.9	1.00±0.30	0.097±0.010	29.4±1.7	-0.41	8.7	59.5	1.0689	1.0038	9.01
LYU33				14	17.6±0.8	0.90±0.38	0.088±0.012	33.7±1.7	-0.37	11.0	62.9	1.0688	1.0019	8.73
LYU21		More underpitched	4 x10 <sup>5</sup>	14	17.6±0.4	0.57±0.15	0.100±0.006	26.7±0.7	-0.42	6.6	53.0	1.0684	1.00277	8.14
LYU22				16	18.8±1.3	0.77±0.29	0.097±0.012	20.6±1.8	-0.44	8.9	57.7	1.0676	1.00366	8.94
LYU23				12	17.1±0.8	0.43±0.23	0.099±0.008	21.2±1.2	-0.41	7.7	55.2	1.0680	1.00275	9.08
LYU11		Underpitched	2 x10 <sup>6</sup>	14	18.4±2.0	-0.25±0.45	0.121±0.030	18.9±2.8	-0.56	2.3	46.4	1.0662	0.99755	8.64
LYU12				11	17.8±1.5	0.38±0.70	0.108±0.029	23.1±2.1	-0.47	4.5	48.9	1.0663	1.00201	7.98
LYU13				9	17.4±1.7	0.53±0.68	0.135±0.047	21.2±2.4	-0.57	6.4	50.7	1.0668	0.99944	8.46
LYO1		Overpitched	2 x10 <sup>8</sup>	14	17.4±0.7	-0.65±0.15	0.269±0.037	10.2±0.7	-1.22	2.8	31.4	1.0666	0.99758	8.71
LYO2				11	16.9±0.7	-0.49±0.19	0.325±0.054	10.2±1.1	-1.42	4.1	36.4	1.0671	0.99823	8.47
LYO3				9	17.4±0.4	-0.52±0.17	0.309±0.045	10.4±1.0	-1.38	3.6	33.2	1.0655	0.99842	8.93
<b>LIQUID YEAST COMBINED</b>														
LYC	Liquid	Control	2 x10 <sup>7</sup>	34	17.5±0.3	-0.56±0.14	0.188 ± 0.010	17.0±0.3	-0.85±0.07	6.4±1.90	41.4±2.73	1.0656± 0.0001	0.9982 ±0.0010	8.82 ±0.12
LYU4		Most underpitched	4 x10 <sup>4</sup>	42	17.8±0.5	1.65±0.36	0.074±0.007	41.3±1.2	-0.30±0.02	14.5±2.24	73.5±1.62	1.0680± 0.0009	1.0050±0.0003	8.45 ±0.38
LYU3		Very underpitched	2 x10 <sup>5</sup>	42	18.5±0.7	0.84± 0.25	0.080±0.006	29.1±1.2	-0.35±0.06	4.1±3.91	62.2±2.47	1.0688±0.0001	1.0026±0.0011	8.72 ±0.30
LYU2		More underpitched	4 x10 <sup>5</sup>	42	17.7±0.2	0.75±0.09	0.108±0.003	25.8±0.4	-0.46±0.01	7.3±1.16	55.1±2.33	1.0680±0.0004	1.0031±0.0005	8.72 ±0.51
LYU1		Underpitched	2 x10 <sup>6</sup>	34	17.2±0.6	0.42±0.24	0.143±0.018	21.8 ± 0.8	-0.60±0.06	7.5±2.04	48.6 ± 2.18	1.0663±0.0001	0.9998±0.0032	8.31 ±0.47
LYO		Overpitched	2 x10 <sup>8</sup>	34	17.2±0.2	-0.50±0.05	0.296±0.013	10.0±0.3	-1.31±0.11	1.3±0.66	33.6±2.55	1.0665±0.0007	0.9991±0.0017	8.64 ±0.22

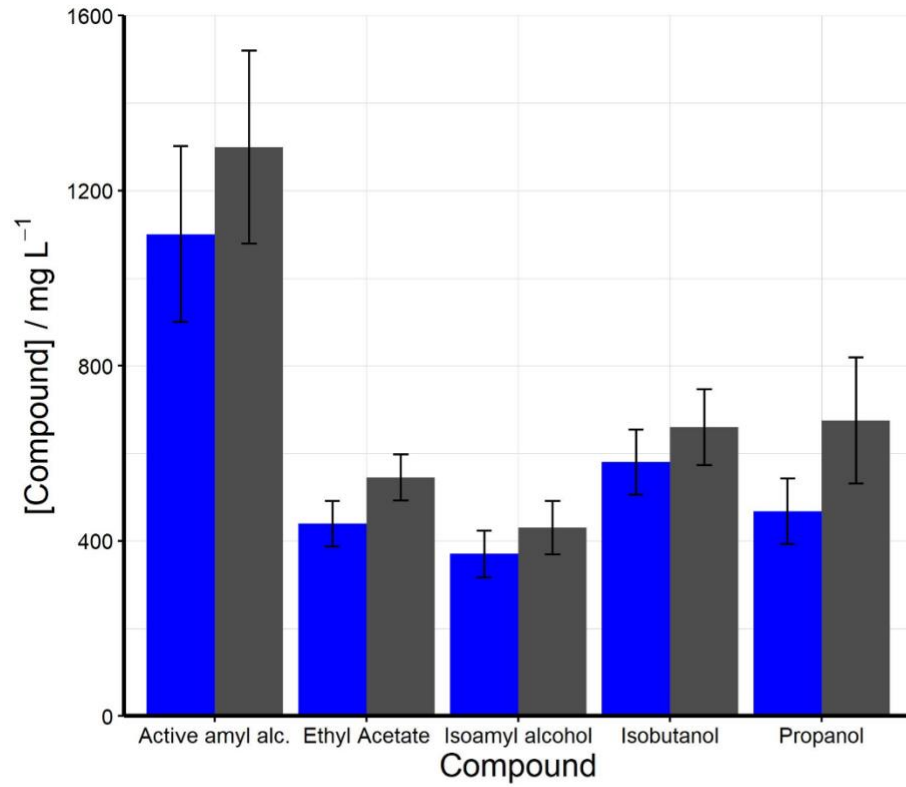
Supplementary 2 – Total yeast cell count comparison between fermentations containing dried and liquid yeast.



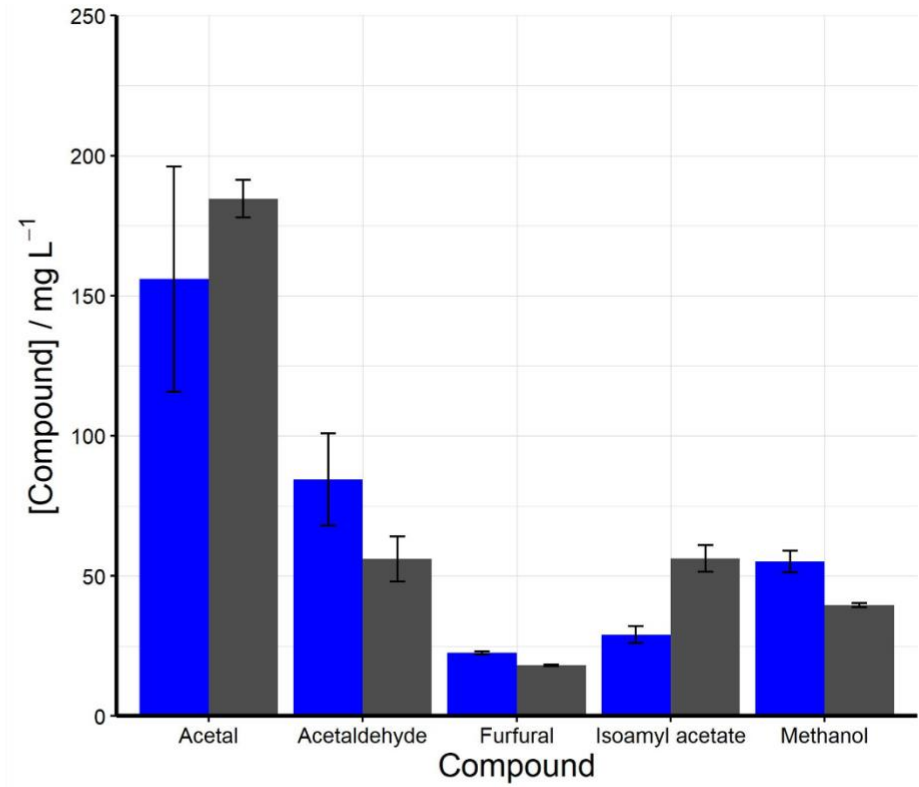
Supplementary 3 – Yeast cell modelling comparison between liquid and dried fermentations.

Ferm. ID	Format	$C_i$ ( $\times 10^7$ cells/mL)	$C_e$ ( $\times 10^8$ cells/mL)	$B_{\text{cells}}$ (/hr)	$M_{\text{cells}}$ (hr)	Lag (hr)	Stationary phase (hr)	Growth rate ( $\mu$ ) (/hr <sup>1</sup> )	Gen. time (hr)
LYC	Liquid	$1.75 \pm 0.04$	$1.10 \pm 0.02$	$0.386 \pm 0.069$	$9.7 \pm 0.5$	4.5	14.9	0.12	5.8
DYC	Dried	$1.79 \pm 0.05$	$1.20 \pm 0.02$	$0.331 \pm 0.082$	$15.7 \pm 1.5$	9.7	21.7	0.11	6.6

Supplementary 4–Higher alcohol and abundant ester concentration of distillate produced using liquid and dried yeast



Format ■ Dried ■ Liquid



Format ■ Dried ■ Liquid

Supplementary 5 – Concentration of ester and ethanol in new-make spirit. Esters measured by SPME-GC/MS and ethanol measured by DMA 35.

Ferm. ID	Format	Pitch rate	Concentration (mg/L)						ABV (%v/v)
			Ethyl caproate	Ethyl caprylate	Phenyl ethyl acetate	Ethyl caprate	Ethyl laurate	Ethyl palmitate	
<b>DRIED YEAST</b>									
DYC1	Dried	1.0g/L	1.45	2.03	6.03	2.39	2.62	0.09	66.9
DYC2			1.17	2.20	7.03	2.55	2.91	0.44	68.3
DYC3			1.29	1.79	7.49	2.30	2.64	0.06	70.0
DYU1		0.5g/L	1.68	2.48	4.73	3.17	3.26	0.31	66.9
DYU2			1.64	2.19	3.44	2.26	2.74	0.46	69.6
DYU3			1.68	2.72	3.75	2.28	2.64	0.23	68.4
DYO1		2.0g/L	1.29	1.73	7.49	1.32	1.63	0.07	67.8
DYO2			1.08	1.36	6.59	1.27	1.90	0.22	67.5
DYO3			0.95	1.59	6.87	1.26	2.63	0.15	68.3
<b>AVERAGE – DRIED YEAST</b>									
DYC	Dried	1.0g/L	1.30 ± 0.11	2.01 ± 0.17	6.85 ± 0.61	2.42 ± 0.10	2.72 ± 0.13	0.20 ± 0.17	68.4 ± 1.6
DYU		0.5g/L	1.67 ± 0.03	2.47 ± 0.27	3.97 ± 0.67	2.57 ± 0.52	2.88 ± 0.33	0.33 ± 0.11	68.3 ± 1.4
DYO		2.0g/L	1.11 ± 0.17	1.56 ± 0.18	6.98 ± 0.46	1.28 ± 0.03	2.05 ± 0.52	0.15 ± 0.08	67.9 ± 0.4

Supplementary 5 (contd) – Concentration of ester and ethanol in new-make spirit. Esters measured by SPME-GC/MS and ethanol measured by DMA 35.

Ferm. ID	Format	Pitch rate (cells/mL)	Concentration (mg/L)					ABV (%v/v)	
			Ethyl caproate	Ethyl caprylate	Phenyl ethyl acetate	Ethyl caprate	Ethyl laurate		Ethyl palmitate
<b>LIQUID YEAST</b>									
LYC1	Liquid	2.00 x10 <sup>7</sup>	1.78	2.90	2.72	3.28	3.70	0.57	69.9
LYC2			1.73	2.49	3.56	2.94	3.61	0.55	68.4
LYC3			1.81	2.90	1.67	2.78	3.24	0.52	68.2
LYU41		4.00 x10 <sup>4</sup>	2.94	2.45	3.46	1.62	3.87	1.03	67.4
LYU42			2.54	2.18	2.54	1.27	3.05	0.72	69.4
LYU43			2.56	2.44	2.42	1.87	2.45	0.58	69.2
LYU31		2.00 x10 <sup>5</sup>	2.47	4.06	3.70	2.74	3.50	0.68	67.3
LYU32			2.52	3.78	3.48	2.04	2.81	0.66	69.8
LYU33			2.27	3.32	3.22	2.93	3.35	0.68	69.5
LYU21		4.00 x10 <sup>5</sup>	2.37	4.85	9.89	6.24	4.01	1.65	69.0
LYU22			2.16	4.61	8.42	4.92	4.66	1.11	69.5
LYU23			2.22	4.09	8.16	4.58	4.17	1.23	69.6
LYU11		2.00 x10 <sup>6</sup>	1.85	2.49	2.07	1.85	2.51	1.50	68.4
LYU12			1.56	2.36	2.53	2.01	2.44	1.02	67.8
LYU13			1.56	2.53	1.99	1.49	2.75	1.54	68.2
LY201		2.00 x10 <sup>8</sup>	0.92	1.37	6.74	1.34	1.29	0.65	67.9
LY202			0.89	1.23	6.64	0.96	1.08	0.72	68.0
LY203			1.21	1.60	6.55	1.10	1.54	0.76	68.2
<b>AVERAGE – LIQUID YEAST</b>									
LYC	Liquid	2.00 x10 <sup>7</sup>	1.77 ± 0.03	2.77 ± 0.19	2.65 ± 0.77	3.00 ± 0.21	3.52 ± 0.20	0.55 ± 0.02	68.8 ± 0.9
LYU4		4.00 x10 <sup>4</sup>	2.68 ± 0.22	2.36 ± 0.15	2.81 ± 0.57	1.59 ± 0.30	3.12 ± 0.72	0.78 ± 0.23	68.7 ± 1.1
LYU3		2.00 x10 <sup>5</sup>	2.42 ± 0.13	3.72 ± 0.37	3.47 ± 0.24	2.57 ± 0.47	3.22 ± 0.36	0.67 ± 0.01	68.9 ± 1.4
LYU2		4.00 x10 <sup>5</sup>	2.25 ± 0.11	4.52 ± 0.39	8.82 ± 0.94	5.25 ± 0.88	4.28 ± 0.34	1.33 ± 0.28	69.4 ± 0.3
LYU1		2.00 x10 <sup>6</sup>	1.66 ± 0.17	2.46 ± 0.09	2.20 ± 0.29	1.78 ± 0.27	2.56 ± 0.16	1.36 ± 0.29	68.1 ± 0.3
LYO		2.00 x10 <sup>8</sup>	1.01 ± 0.18	1.40 ± 0.18	6.65 ± 0.10	1.14 ± 0.19	1.30 ± 0.23	0.71 ± 0.05	68.0 ± 0.2

Supplementary 6 – Higher alcohol and abundant ester concentration measured by GC/FID.

Ferm. ID	Format	Pitch rate	Concentration (mg/L)								
			Acetaldehyde	Ethyl acetate	Acetal	Methanol	n-Propanol	Isobutanol	Isoamyl acetate	2-methyl-1-butanol	Furfural
<b>DRIED YEAST</b>											
DYC1	Dried	1.0g/L	59	429	113	55	453	605	30	1192	22
DYC2			68	372	193	59	325	395	32	731	23
DYC3			126	516	162	51	626	740	26	1378	23
DYU1		0.5g/L	103	277	183	40	351	519	18	1067	15
DYU2			22	155	69	53	387	753	20	1364	25
DYU3			96	354	195	41	471	501	17	862	23
DYO1		2.0g/L	32	436	154	41	702	799	30	1681	20
DYO2			31	240	62	44	249	790	27	1138	24
DYO3			18	186	38	30	592	809	25	1674	19
<b>AVERAGE – DRIED YEAST</b>											
DYC	Dried	1.0g/L	85 ± 36	439 ± 72	156 ± 40	55 ± 4	468 ± 151	580 ± 174	29 ± 3	1100 ± 333	23 ± 1
DYU		0.5g/L	74 ± 45	262 ± 100	149 ± 69	45 ± 7	403 ± 62	591 ± 141	18 ± 2	1098 ± 252	21 ± 5
DYO		2 g/L	27 ± 8	287 ± 132	85 ± 62	38 ± 7	514 ± 237	799 ± 10	27 ± 3	1498 ± 312	21 ± 3

Supplementary 6 (contd) – Higher alcohol and abundant ester concentration measured by GC/FID.

Ferm. ID	Format	Pitch rate (cells/mL)	Concentration (mg/L)									
			Acetaldehyde	Ethyl acetate	Acetal	Methanol	n-Propanol	Isobutanol	Isoamyl acetate	2-methyl-1-butanol	Furfural	
<b>LIQUID YEAST</b>												
LYC1	Liquid	2.00 x10 <sup>7</sup>	48	465	178	40	819	755	52	1536	18	
LYC2			64	607	192	39	531	585	61	1100	18	
LYC3			56	563	184	40	676	639	56	1262	18	
LYU41		4.00 x10 <sup>4</sup>	43	373	157	44	360	351	25	658	23	
LYU42			15	130	135	43	423	789	31	1339	27	
LYU43			40	462	143	37	417	387	24	743	22	
LYU31		2.00 x10 <sup>5</sup>	43	334	201	50	370	574	43	939	26	
LYU32			49	414	108	16	243	497	11	1163	23	
LYU33			64	427	65	40	561	895	19	1592	23	
LYU21		4.00 x10 <sup>5</sup>	34	602	45	26	412	518	48	937	24	
LYU22			45	385	66	24	422	634	11	1052	26	
LYU23			54	434	50	31	452	447	13	1022	23	
LYU11		2.00 x10 <sup>6</sup>	87	363	162	43	448	427	19	921	27	
LYU12			41	470	139	36	656	551	34	1129	17	
LYU13			87	500	210	42	169	556	15	1646	27	
LY201		2.00 x10 <sup>8</sup>	66	517	63	40	459	751	29	1809	19	
LY202			52	484	34	26	557	859	23	1635	17	
LY203			67	417	41	28	417	946	33	1903	19	
<b>AVERAGE – LIQUID YEAST</b>												
LYC	Liquid	2.00 x10 <sup>7</sup>	56± 8	545 ± 73	185 ± 7	40 ± 1	675 ± 144	660 ± 87	56 ± 5	1300 ± 221	18 ± 0	
LYU4		4.00 x10 <sup>4</sup>	33 ± 16	322 ± 172	145 ± 11	41 ± 4	400 ± 35	509 ± 243	26 ± 4	913 ± 371	24 ± 3	
LYU3		2.00 x10 <sup>5</sup>	48 ± 13	444 ± 113	105 ± 69	33 ± 15	397 ± 131	621 ± 186	30 ± 18	1158± 308	24 ± 1	
LYU2		4.00 x10 <sup>5</sup>	44 ± 10	473 ± 114	54 ± 11	27 ± 3	429 ± 21	533 ± 95	24 ± 21	1004 ± 60	24 ± 1	
LYU1		2.00 x10 <sup>6</sup>	72 ± 26	445 ± 72	170 ± 36	40 ± 4	425 ± 244	511 ± 73	23 ± 10	1232 ± 374	24 ± 5	
LYO		2.00 x10 <sup>8</sup>	61 ± 8	473 ± 51	46 ± 15	31 ± 7	478 ± 72	852 ± 98	28 ± 5	1783 ± 136	18 ± 1	