

**Addition of glutamine enhances the quality of Huangjiu by modifying the assembly and metabolic activities of microorganisms during the fermentation process**

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**Table S1.** Content of volatile components at the end of fermentation (µg/L)

No.	Volatile components	CK	Glu	Gln	Asp	Asn
A1	Acetic acid, 2-methylpropyl ester	41.73±4.42 <sup>ab</sup>	42.12±0.26 <sup>ab</sup>	32.33±2.50 <sup>b</sup>	46.35±1.53 <sup>a</sup>	35.61±2.00 <sup>ab</sup>
A2	Butanoic acid, ethyl ester	12.05±1.44 <sup>d</sup>	29.73±1.08 <sup>b</sup>	23.74±1.73 <sup>c</sup>	23.78±2.85 <sup>c</sup>	37.00±0.41 <sup>a</sup>
A3	1-Butanol, 3-methyl-, acetate	345.28±74.41 <sup>a</sup>	318.45±19.39 <sup>a</sup>	215.10±18.89 <sup>bc</sup>	285.06±39.25 <sup>ab</sup>	185.95±22.69 <sup>c</sup>
A4	Pentanoic acid, ethyl ester	11.88±0.64 <sup>b</sup>	14.33±0.66 <sup>a</sup>	10.25±0.42 <sup>b</sup>	11.78±2.40 <sup>b</sup>	9.75±0.23 <sup>b</sup>
A5	Hexanoic acid, ethyl ester	273.92±26.56 <sup>a</sup>	254.06±30.09 <sup>a</sup>	191.19±9.31 <sup>b</sup>	191.06±24.45 <sup>b</sup>	180.22±10.81 <sup>b</sup>
A6	Acetic acid, hexyl ester	4.19±0.39 <sup>c</sup>	6.97±0.63 <sup>a</sup>	5.62±0.99 <sup>b</sup>	5.39±0.13 <sup>b</sup>	2.83±0.50 <sup>d</sup>
A7	Heptanoic acid, ethyl ester	31.65±6.92 <sup>a</sup>	28.81±0.77 <sup>a</sup>	16.05±0.29 <sup>b</sup>	13.46±3.64 <sup>bc</sup>	10.75±0.74 <sup>c</sup>
A8	Propanoic acid, 2-hydroxy-, ethyl ester	76.54±5.46 <sup>ab</sup>	69.39±4.37 <sup>ab</sup>	66.67±8.51 <sup>b</sup>	81.14±9.50 <sup>a</sup>	73.08±6.05 <sup>ab</sup>
A9	Isopentyl hexanoate	8.00±1.93	/	/	/	/
A10	Nonanoic acid, ethyl ester	63.45±8.54 <sup>a</sup>	58.03±22.22 <sup>a</sup>	15.82±3.99 <sup>b</sup>	/	/
A11	Decanoic acid, ethyl ester	375.97±33.65 <sup>a</sup>	279.31±27.37 <sup>b</sup>	129.97±8.79 <sup>c</sup>	139.42±27.95 <sup>c</sup>	40.85±3.53 <sup>d</sup>
A12	Acetic acid, 2-phenylethyl ester	84.22±11.07 <sup>a</sup>	54.83±5.76 <sup>ab</sup>	36.88±3.45 <sup>ab</sup>	40.85±1.01 <sup>ab</sup>	32.78±2.37 <sup>b</sup>
A13	2(3H)-Furanone, dihydro-5-pentyl-Nonanoic acid, 9-oxo-, methyl ester	14.22±0.94 <sup>a</sup>	12.72±0.34 <sup>a</sup>	/	/	/
A14	Isopropyl Myristate	163.74±2.89 <sup>a</sup>	73.21±2.17 <sup>b</sup>	58.26±1.62 <sup>c</sup>	38.39±0.84 <sup>d</sup>	29.80±3.27 <sup>e</sup>
A15	Tetradecanoic acid, ethyl ester	18.25±1.20 <sup>a</sup>	/	10.65±0.23 <sup>c</sup>	/	14.08±1.09 <sup>b</sup>
A16	Hexadecanoic acid, methyl ester	187.92±2.91 <sup>b</sup>	235.25±14.76 <sup>a</sup>	117.29±0.92 <sup>c</sup>	127.69±19.32 <sup>c</sup>	78.55±18.58 <sup>d</sup>
A17	Hexadecanoic acid, ethyl ester	37.24±1.66 <sup>a</sup>	17.87±5.50 <sup>b</sup>	27.71±16.93 <sup>ab</sup>	/	35.75±1.64 <sup>a</sup>
A18	Octadecanoic acid, ethyl ester	937.61±59.98 <sup>b</sup>	1121.51±60.94 <sup>a</sup>	642.68±12.64 <sup>d</sup>	806.20±85.45 <sup>c</sup>	576.29±81.58 <sup>d</sup>
A19	Methyl 8-oxooctanoate	16.46±1.94 <sup>a</sup>	16.11±0.52 <sup>a</sup>	/	/	/
A20	9-Octadecenoic acid (Z)-, methyl ester	/	11.97±0.17	/	/	/
A21	Butanedioic acid, diethyl ester	/	37.24±4.56 <sup>a</sup>	/	27.70±0.16 <sup>b</sup>	/
A22	E-11-Hexadecenoic acid, ethyl ester	/	12.59±2.02 <sup>a</sup>	8.76±0.20 <sup>b</sup>	7.12±0.24 <sup>b</sup>	/
A23	2,2,4-Trimethyl-1,3-pentanediol diisobutyrate	/	23.41±0.87	/	/	/
A24	Benzoic acid, ethyl ester	/	/	7.41±1.13 <sup>a</sup>	/	9.11±1.03 <sup>a</sup>
A25	10-Octadecenoic acid, methyl ester	/	/	5.62±0.24 <sup>a</sup>	/	3.02±0.36 <sup>b</sup>
A26	Dodecanoic acid, ethyl ester	/	/	31.98±3.95	/	/
A27	gamma-Decanolactone	/	/	/	/	20.98±0.74
A28	Total	/	/	/	/	12.04±1.31
B1	1-Propanol, 2-methyl-1-Butanol, 3-methyl-1-Hexanol	2704.31±246.95 <sup>a</sup>	2717.92±204.46 <sup>a</sup>	1653.99±96.71 <sup>c</sup>	1845.38±218.71 <sup>b</sup>	1376.41±157.61 <sup>d</sup>
B2	2,3-Butanediol, [R-(R*,R*)]-	531.40±5.26 <sup>b</sup>	444.15±39.92 <sup>d</sup>	485.43±8.47 <sup>c</sup>	591.34±20.46 <sup>a</sup>	496.64±12.88 <sup>c</sup>
B3		2499.58±240.37 <sup>a</sup>	2361.50±187.47 <sup>a</sup>	1827.32±235.46 <sup>b</sup>	2659.17±31.04 <sup>a</sup>	1936.82±328.19 <sup>b</sup>
B4		50.79±1.95 <sup>ab</sup>	56.23±3.39 <sup>a</sup>	45.06±0.35 <sup>b</sup>	54.78±6.17 <sup>a</sup>	50.50±1.94 <sup>ab</sup>
B5		69.50±1.10 <sup>bc</sup>	77.76±11.27 <sup>ab</sup>	55.10±6.22 <sup>c</sup>	74.69±7.05 <sup>ab</sup>	87.73±12.53 <sup>a</sup>

B5	Silanediol, dimethyl-	145.73±9.33 <sup>a</sup>	107.56±23.50 <sup>b</sup>	77.75±8.03 <sup>c</sup>	/	71.70±10.62 <sup>c</sup>
B6	1-Nonanol	19.16±0.84 <sup>a</sup>	18.93±0.67 <sup>a</sup>	10.38±0.85 <sup>c</sup>	14.50±2.02 <sup>b</sup>	14.73±2.68 <sup>b</sup>
B7	Phenylethyl Alcohol	676.47±17.66 <sup>a</sup>	459.49±5.69 <sup>b</sup>	369.02±14.86 <sup>d</sup>	428.68±14.12 <sup>c</sup>	416.05±25.28 <sup>c</sup>
B8	1-Octanol	/	22.67±2.37	/	/	/
B9	1-Heptanol	/	13.84±1.12 <sup>a</sup>	7.79±0.03 <sup>b</sup>	/	8.11±0.92 <sup>b</sup>
B10	2-Nonanol	/	/	5.26±1.38 <sup>a</sup>	/	3.60±0.39 <sup>a</sup>
B11	2-Hexadecanol	/	/	8.03±0.81	/	/
B12	Ethanol, 2-(dodecyloxy)-	/	/	10.57±1.53 <sup>a</sup>	/	9.75±0.31 <sup>a</sup>
B13	1-Pentanol	/	/	2.76±0.45 <sup>a</sup>	2.92±0.21 <sup>a</sup>	/
B14	1-Propanol, 3-(methylthio)-	/	/	/	7.71±0.00 <sup>a</sup>	3.43±0.09 <sup>b</sup>
B15	E-11,13-Tetradecadien-1-ol	/	/	/	71.17±5.66	/
B16	2-Pentadecanol	/	/	/	5.74±0.66 <sup>b</sup>	11.79±1.40 <sup>a</sup>
B17	1-Propanol, 3-ethoxy-	/	/	/	/	3.87±0.65
B18	Cedrol	/	/	/	/	9.70±0.46
	Total	3992.63±276.51 <sup>a</sup>	3562.12±275.40 <sup>ab</sup>	2904.48±278.43 <sup>c</sup>	3910.71±87.39 <sup>a</sup>	3124.40±398.34 <sup>bc</sup>
C1	Acetic acid	647.71±221.53 <sup>bc</sup>	440.17±157.67 <sup>c</sup>	963.94±156.12 <sup>a</sup>	1000.31±231.83 <sup>a</sup>	856.79±39.50 <sup>ab</sup>
C2	Nonanoic acid	13.60±1.29 <sup>a</sup>	/	/	7.89±1.65 <sup>b</sup>	7.67±0.27 <sup>b</sup>
C3	Hexanoic acid	/	/	/	/	6.49±0.75
C4	Octanoic Acid	/	/	/	/	6.89±0.09
	Total	661.31±222.82 <sup>bc</sup>	440.17±157.67 <sup>c</sup>	963.94±156.12 <sup>ab</sup>	1008.20±233.48 <sup>a</sup>	877.84±40.62 <sup>ab</sup>
D1	Nonanal	13.36±2.22 <sup>a</sup>	9.95±0.62 <sup>ab</sup>	5.18±0.74 <sup>b</sup>	6.56±0.35 <sup>ab</sup>	8.78±0.23 <sup>ab</sup>
D2	Decanal	17.87±1.11 <sup>a</sup>	18.67±1.16 <sup>a</sup>	9.74±1.40 <sup>c</sup>	18.62±0.74 <sup>a</sup>	12.15±1.91 <sup>b</sup>
D3	Hexadecanal	/	/	/	/	8.32±0.11
	Total	31.23±3.33 <sup>a</sup>	28.62±1.78 <sup>ab</sup>	14.92±2.14 <sup>c</sup>	25.17±1.09 <sup>b</sup>	29.26±2.26 <sup>ab</sup>
E1	2-Octanone	10.47±1.39 <sup>a</sup>	10.14±1.02 <sup>a</sup>	11.55±2.25 <sup>a</sup>	9.62±1.42 <sup>a</sup>	12.62±2.12 <sup>a</sup>
E2	Benzofuran, 2,3-dihydro-	29.52±2.62 <sup>a</sup>	21.09±0.08 <sup>b</sup>	16.23±1.84 <sup>c</sup>	19.82±3.15 <sup>bc</sup>	22.89±1.59 <sup>b</sup>
E3	2-Methoxy-4-vinylphenol	116.83±9.54 <sup>a</sup>	83.58±5.21 <sup>b</sup>	79.01±4.44 <sup>b</sup>	64.92±7.91 <sup>c</sup>	78.28±3.46 <sup>b</sup>
E4	Phenol, 2,4-bis(1,1-dimethylethyl)-	807.87±69.55 <sup>b</sup>	/	/	731.40±27.17 <sup>b</sup>	1869.83±87.39 <sup>a</sup>
E5	Phenol, 3,5-bis(1,1-dimethylethyl)-	/	787.51±80.71	/	/	/
	Cyclohexene, 1-methyl-4-(1-methylethenyl)-, (S)-	17.88±1.44 <sup>b</sup>	6.78±1.22 <sup>c</sup>	/	29.67±8.58 <sup>a</sup>	/
E7	2-Tetradecene, (E)-	/	6.12±2.51 <sup>b</sup>	/	18.74±2.71 <sup>a</sup>	/
E8	5-Tetradecene, (E)-	/	/	6.16±0.20	/	/
E9	7-Tetradecene, (Z)-	/	/	/	46.75±10.61	/
	Total	1210.69±113.69 <sup>b</sup>	1040.74±101.14 <sup>b</sup>	249.99±25.96 <sup>c</sup>	933.43±62.91 <sup>b</sup>	2224.81±100.74 <sup>a</sup>

**Table S2.** Free amino acid content in the end of fermentation (mg/L)

Amino acid	CK	Glu	Gln	Asp	Asn
Asp	95.18±2.45 <sup>a</sup>	91.77±2.15 <sup>b</sup>	84.13±0.35 <sup>c</sup>	91.93±0.35 <sup>b</sup>	82.07±1.72 <sup>c</sup>
Glu	209.86±4.88 <sup>a</sup>	202.52±4.77 <sup>b</sup>	188.22±1.62 <sup>c</sup>	199.33±4.40 <sup>b</sup>	174.59±1.58 <sup>d</sup>
Ser	114.22±7.95 <sup>b</sup>	119.95±1.01 <sup>b</sup>	119.09±0.66 <sup>b</sup>	133.54±1.44 <sup>a</sup>	117.80±2.07 <sup>b</sup>
Gly	188.56±3.10 <sup>b</sup>	186.71±2.70 <sup>bc</sup>	177.78±0.39 <sup>c</sup>	201.92±0.26 <sup>a</sup>	179.10±10.86 <sup>bc</sup>
His	60.93±0.48 <sup>d</sup>	66.22±0.74 <sup>c</sup>	67.86±0.39 <sup>bc</sup>	71.19±0.65 <sup>a</sup>	69.38±2.01 <sup>ab</sup>
Thr	78.10±5.20 <sup>b</sup>	83.98±1.08 <sup>b</sup>	78.71±1.27 <sup>b</sup>	91.80±1.70 <sup>a</sup>	80.29±4.51 <sup>b</sup>
Arg	270.51±5.38 <sup>a</sup>	264.26±6.29 <sup>a</sup>	239.89±2.90 <sup>b</sup>	267.94±8.17 <sup>a</sup>	239.90±7.88 <sup>b</sup>
Ala	601.23±1.18 <sup>b</sup>	602.50±7.00 <sup>b</sup>	580.15±8.55 <sup>c</sup>	633.47±6.55 <sup>a</sup>	579.74±0.54 <sup>c</sup>
Pro	279.77±1.06 <sup>b</sup>	272.72±0.98 <sup>c</sup>	247.42±0.40 <sup>d</sup>	287.80±5.28 <sup>a</sup>	240.70±3.87 <sup>e</sup>
Tyr	295.46±1.47 <sup>c</sup>	303.93±5.65 <sup>b</sup>	300.60±2.17 <sup>bc</sup>	333.85±4.05 <sup>a</sup>	299.01±4.98 <sup>bc</sup>
Val	231.38±6.50 <sup>d</sup>	240.95±3.94 <sup>bc</sup>	236.44±2.42 <sup>cd</sup>	264.50±2.40 <sup>a</sup>	245.64±0.67 <sup>b</sup>
Met	105.30±5.92 <sup>b</sup>	111.47±1.04 <sup>b</sup>	108.92±2.30 <sup>b</sup>	119.36±2.79 <sup>a</sup>	105.65±2.69 <sup>b</sup>
Ile	43.39±2.13 <sup>c</sup>	48.36±0.76 <sup>ab</sup>	46.15±1.99 <sup>bc</sup>	50.46±1.44 <sup>a</sup>	46.57±0.67 <sup>b</sup>
Leu	152.74±8.03 <sup>c</sup>	164.76±4.26 <sup>b</sup>	166.59±4.47 <sup>ab</sup>	175.61±2.96 <sup>a</sup>	164.19±4.52 <sup>b</sup>
Cys	380.09±7.44 <sup>c</sup>	399.68±6.51 <sup>b</sup>	391.48±1.87 <sup>bc</sup>	449.47±3.36 <sup>a</sup>	394.91±11.21 <sup>b</sup>
Phe	344.80±8.13 <sup>b</sup>	355.26±5.70 <sup>b</sup>	354.03±8.51 <sup>b</sup>	398.29±5.41 <sup>a</sup>	358.20±6.06 <sup>b</sup>
Lys	223.96±2.61 <sup>d</sup>	251.29±3.99 <sup>c</sup>	258.40±6.57 <sup>bc</sup>	281.85±5.29 <sup>a</sup>	262.61±2.31 <sup>b</sup>
Total	3675.48±57.91 <sup>c</sup>	3766.33±28.56 <sup>b</sup>	3645.87±24.27 <sup>c</sup>	4052.34±12.69 <sup>a</sup>	3640.33±46.10 <sup>c</sup>

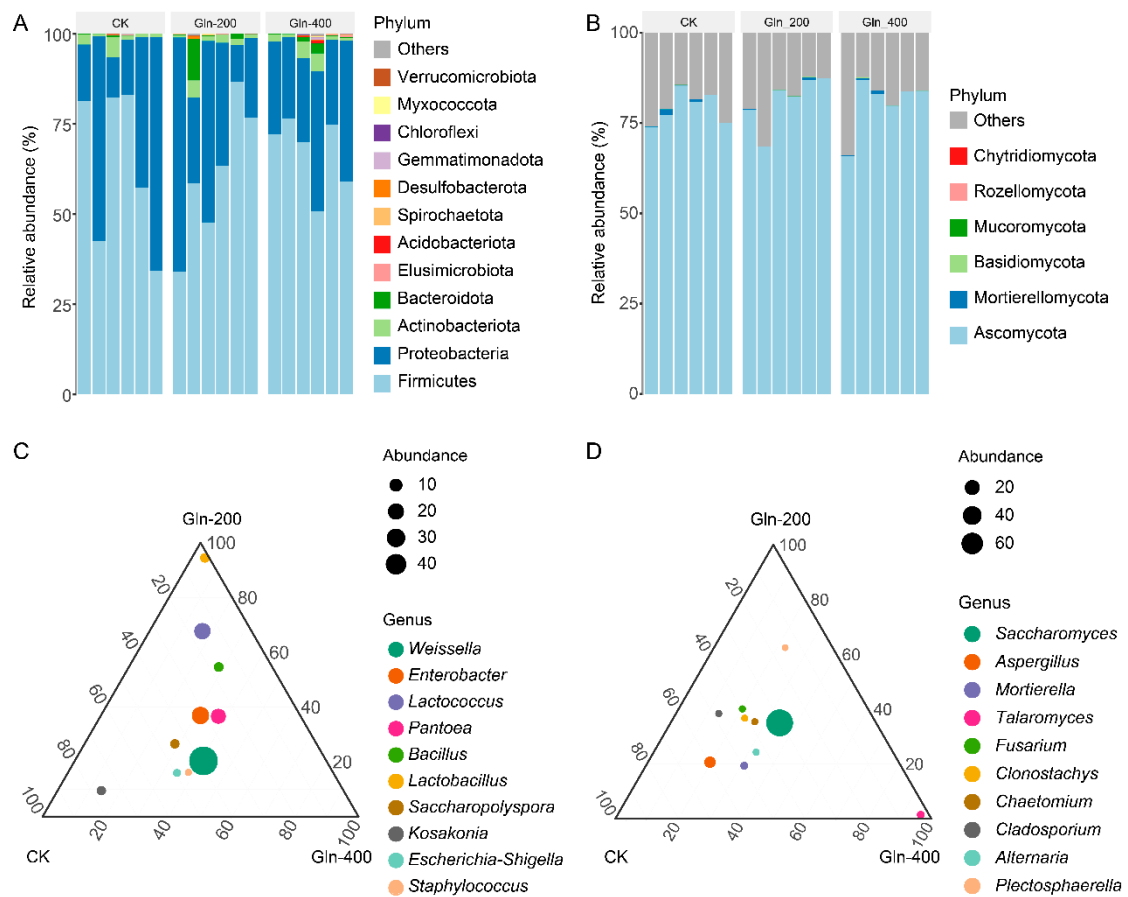
**Table S3.** Effect of Gln addition on volatile components (µg/L)

No.	Volatile components	CK	Glu-200	Glu-400
A1	Acetic acid, pentyl ester	513.72±56.14 <sup>ab</sup>	584.04±30.06 <sup>a</sup>	467.82±20.88 <sup>b</sup>
A2	Pentanoic acid, ethyl ester	28.04±1.75 <sup>b</sup>	31.92±1.00 <sup>a</sup>	32.00±1.82 <sup>a</sup>
A3	Hexanoic acid, ethyl ester	624.02±16.64 <sup>a</sup>	617.32±10.69 <sup>a</sup>	627.48±11.63 <sup>a</sup>
A4	Acetic acid, hexyl ester	7.47±1.34 <sup>b</sup>	5.54±0.27 <sup>b</sup>	9.52±1.07 <sup>a</sup>
A5	Propanoic acid, 2-hydroxy-, ethyl ester	161.83±31.30 <sup>a</sup>	36.19±1.09 <sup>c</sup>	80.94±1.57 <sup>b</sup>
A6	Heptanoic acid, ethyl ester	86.81±5.32 <sup>a</sup>	82.07±6.06 <sup>a</sup>	77.86±5.89 <sup>a</sup>
A7	Octanoic acid, ethyl ester	402.51±29.00 <sup>a</sup>	358.05±30.09 <sup>a</sup>	374.19±43.90 <sup>a</sup>
A8	Isopentyl hexanoate	5.73±0.42 <sup>b</sup>	7.38±0.05 <sup>a</sup>	/
A9	Isoamyl lactate	4.40±1.04 <sup>b</sup>	6.33±1.44 <sup>ab</sup>	7.14±0.42 <sup>a</sup>
A10	Nonanoic acid, ethyl ester	59.58±5.20 <sup>a</sup>	39.68±0.21 <sup>b</sup>	42.20±6.38 <sup>b</sup>
A11	Butanedioic acid, diethyl ester	6.30±1.31 <sup>a</sup>	6.02±0.58 <sup>ab</sup>	4.38±0.32 <sup>b</sup>
A12	Decanoic acid, ethyl ester	144.50±3.36 <sup>ab</sup>	123.18±20.61 <sup>b</sup>	157.39±17.82 <sup>a</sup>
A13	4-Decenoic acid, ethyl ester, (Z)-	5.44±0.84	/	/
A14	Acetic acid, 2-phenylethyl ester	54.59±1.62 <sup>a</sup>	40.19±0.29 <sup>b</sup>	40.88±8.85 <sup>b</sup>
A15	Dodecanoic acid, ethyl ester	28.87±0.23 <sup>b</sup>	40.32±2.91 <sup>a</sup>	25.51±2.78 <sup>b</sup>
A16	2(3H)-Furanone, dihydro-5-pentyl-	17.33±0.93 <sup>b</sup>	17.97±1.28 <sup>ab</sup>	20.69±2.20 <sup>a</sup>
A17	Tetradecanoic acid, ethyl ester	111.03±17.18 <sup>a</sup>	54.20±5.29 <sup>b</sup>	/
A18	Hexadecanoic acid, methyl ester	42.54±4.93 <sup>a</sup>	/	30.53±5.53 <sup>b</sup>
A19	Diethyl Phthalate	44.94±2.24 <sup>a</sup>	38.09±0.86 <sup>b</sup>	38.77±1.89 <sup>b</sup>
A20	Hexadecanoic acid, ethyl ester	374.89±14.99 <sup>a</sup>	231.69±22.63 <sup>b</sup>	249.96±18.25 <sup>b</sup>
A21	1,2-Benzenedicarboxylic acid, bis(2-methylpropyl) ester	20.46±1.50 <sup>a</sup>	/	25.34±6.20 <sup>a</sup>
A22	(E)-9-Octadecenoic acid ethyl ester	131.38±17.06 <sup>a</sup>	93.31±4.58 <sup>b</sup>	120.57±23.61 <sup>ab</sup>
A23	Benzoic acid, ethyl ester	3.53±0.03 <sup>a</sup>	3.23±0.09 <sup>a</sup>	3.77±0.97 <sup>a</sup>
A24	Ethyl tridecanoate	107.10±21.31 <sup>a</sup>	/	117.75±7.36 <sup>a</sup>
A25	9-Octadecenoic acid (Z)-, methyl ester	88.44±42.31 <sup>a</sup>	/	36.66±9.80 <sup>b</sup>
A26	9,12-Octadecadienoic acid, methyl ester	17.74±0.88	/	/
A27	Linoleic acid ethyl ester	130.59±11.39 <sup>a</sup>	49.56±7.85 <sup>b</sup>	96.21±19.09 <sup>b</sup>
A28	Benzeneacetic acid, ethyl ester	/	3.52±0.57	/
A29	Oxalic acid, 2-ethylhexyl pentyl ester	/	/	16.95±1.63
	Total	3223.77±26.28 <sup>a</sup>	2469.81±54.18 <sup>c</sup>	2704.53±64.95 <sup>b</sup>
B1	1-Propanol, 2-methyl-	501.33±40.92 <sup>b</sup>	697.22±60.93 <sup>a</sup>	630.06±99.37 <sup>ba</sup>
B2	1-Butanol, 3-methyl-	2430.98±206.95 <sup>c</sup>	3820.18±106.63 <sup>a</sup>	3085.77±317.68 <sup>b</sup>
B3	2-Heptanol	4.47±0.41 <sup>a</sup>	3.69±0.10 <sup>ab</sup>	3.41±0.56 <sup>b</sup>
B4	1-Hexanol	56.56±2.18 <sup>a</sup>	55.50±3.13 <sup>a</sup>	59.59±3.11 <sup>a</sup>
B5	1-Octen-3-ol	13.75±0.84 <sup>a</sup>	13.36±1.55 <sup>a</sup>	14.83±1.50 <sup>a</sup>
B6	1-Heptanol	14.03±1.04 <sup>b</sup>	16.08±0.49 <sup>a</sup>	16.15±0.39 <sup>a</sup>
B7	1-Octanol	25.21±1.90 <sup>a</sup>	27.92±1.60 <sup>a</sup>	25.87±2.67 <sup>a</sup>
B8	1-Nonanol	12.67±0.69 <sup>c</sup>	16.41±0.14 <sup>a</sup>	14.75±1.05 <sup>b</sup>
B9	Phenylethyl Alcohol	490.95±3.73 <sup>b</sup>	585.97±3.66 <sup>a</sup>	540.74±46.08 <sup>ab</sup>
B10	1-Butanol	5.77±0.18 <sup>b</sup>	8.57±0.44 <sup>a</sup>	9.12±0.66 <sup>a</sup>
B11	2,3-Butanediol	44.28±1.06 <sup>b</sup>	52.77±0.63 <sup>a</sup>	46.14±1.21 <sup>b</sup>

B12	Silanediol, dimethyl-	21.13±0.50 <sup>b</sup>	24.01±0.83 <sup>a</sup>	24.33±0.00 <sup>a</sup>
B13	1-Octanol, 2-butyl-	8.28±0.01 <sup>b</sup>	11.78±0.53 <sup>a</sup>	10.48±1.96 <sup>ab</sup>
B14	2-Tetradecanol	7.72±1.20	/	/
B15	6-Octen-1-ol, 3,7-dimethyl-	/	3.72±1.13	/
B16	2-Heptanol, (S)-	/	4.81±0.37	/
B17	Ethanol, 2-(dodecyloxy)-	/	/	12.36±5.50
B18	1-Dodecanol	/	/	12.24±4.77
	Total	3637.14±222.72 <sup>c</sup>	5341.99±176.03 <sup>a</sup>	4505.84±271.55 <sup>b</sup>
C1	Acetic acid	435.77±66.63 <sup>a</sup>	276.84±55.26 <sup>b</sup>	441.46±35.27 <sup>a</sup>
C2	Propanoic acid, 2-methyl-	13.64±3.51 <sup>b</sup>	23.36±1.20 <sup>a</sup>	22.34±4.17 <sup>a</sup>
C3	Hexanoic acid	9.89±1.19 <sup>b</sup>	11.22±1.13 <sup>ab</sup>	14.80±3.37 <sup>a</sup>
C4	Octanoic Acid	15.53±0.32 <sup>b</sup>	18.23±0.46 <sup>a</sup>	16.10±0.83 <sup>b</sup>
C5	Nonanoic acid	5.22±2.03 <sup>a</sup>	/	5.77±0.45 <sup>a</sup>
C6	n-Decanoic acid	14.68±0.31 <sup>a</sup>	14.92±1.25 <sup>a</sup>	13.95±0.47 <sup>a</sup>
C7	Butanoic acid	/	10.70±6.67	/
	Total	494.73±70.97 <sup>a</sup>	355.28±65.63 <sup>b</sup>	514.41±28.50 <sup>a</sup>
D1	Decanal	6.08±0.63 <sup>b</sup>	14.50±1.64 <sup>a</sup>	8.38±2.54 <sup>b</sup>
D2	Benzaldehyde, 2,4-dimethyl-	16.40±2.48 <sup>a</sup>	16.24±3.38 <sup>a</sup>	17.93±2.12 <sup>a</sup>
	Total	22.48±1.85 <sup>b</sup>	30.74±2.89 <sup>a</sup>	26.30±0.42 <sup>b</sup>
E1	2-Octanone	10.70±0.51 <sup>b</sup>	14.49±2.19 <sup>a</sup>	12.66±0.34 <sup>ab</sup>
E2	2-Decanone	/	6.27±1.01 <sup>a</sup>	6.39±0.60 <sup>a</sup>
E3	2-Nonanone	/	4.22±0.73 <sup>a</sup>	2.37±0.06 <sup>b</sup>
	Total	10.70±0.51 <sup>c</sup>	24.98±2.60 <sup>a</sup>	21.41±0.92 <sup>b</sup>
F1	2-Methoxy-4-vinylphenol	36.80±4.94 <sup>c</sup>	70.79±2.55 <sup>a</sup>	51.22±0.96 <sup>b</sup>
F2	Limonene	/	27.31±2.38	/
F3	Phenol, 2,4-bis(1,1-dimethylethyl)-	/	15.58±1.10 <sup>a</sup>	11.48±4.10 <sup>a</sup>
	Total	36.80±4.94 <sup>c</sup>	113.68±1.27 <sup>a</sup>	62.70±3.35 <sup>b</sup>

**Table S4.** Effect of Gln addition on free amino acids (mg/L)

Amino acid	CK	Gln-200	Gln-400
Asp	74.58±3.30 <sup>a</sup>	76.15±2.44 <sup>a</sup>	78.94±0.97 <sup>a</sup>
Glu	143.15±0.86 <sup>a</sup>	145.71±23.65 <sup>a</sup>	121.78±1.27 <sup>a</sup>
Umami amino acids	217.73±3.03 <sup>a</sup>	221.86±21.60 <sup>a</sup>	200.72±2.24 <sup>a</sup>
Ser	88.55±3.27 <sup>a</sup>	92.35±0.89 <sup>a</sup>	92.66±1.21 <sup>a</sup>
Gly	150.88±3.78 <sup>b</sup>	178.81±12.74 <sup>a</sup>	175.44±9.19 <sup>a</sup>
Thr	86.98±2.62 <sup>c</sup>	96.21±3.16 <sup>b</sup>	101.92±2.48 <sup>a</sup>
Ala	212.31±3.90 <sup>a</sup>	264.80±6.94 <sup>b</sup>	216.95±11.95 <sup>a</sup>
Pro	166.34±6.01 <sup>c</sup>	201.51±4.84 <sup>b</sup>	212.86±3.46 <sup>a</sup>
Sweet amino acids	705.06±7.86 <sup>c</sup>	833.67±20.48 <sup>a</sup>	799.84±14.77 <sup>b</sup>
His	76.74±4.51 <sup>a</sup>	78.46±1.19 <sup>a</sup>	74.49±5.17 <sup>a</sup>
Arg	580.27±6.78 <sup>b</sup>	717.43±19.20 <sup>a</sup>	721.26±15.78 <sup>a</sup>
Tyr	299.06±8.29 <sup>b</sup>	317.04±6.04 <sup>a</sup>	311.08±6.69 <sup>ab</sup>
Val	226.57±6.64	223.43±4.40	221.32±0.62
Ile	109.35±4.65 <sup>b</sup>	120.25±1.34 <sup>a</sup>	116.14±0.96 <sup>a</sup>
Leu	322.87±12.50 <sup>b</sup>	357.08±6.22 <sup>a</sup>	369.47±2.09 <sup>a</sup>
Phe	311.64±6.18 <sup>b</sup>	329.92±2.71 <sup>a</sup>	337.44±2.22 <sup>a</sup>
Lys	282.33±10.83 <sup>b</sup>	309.10±2.35 <sup>a</sup>	314.21±4.93 <sup>a</sup>
Bitter amino acids	2208.82±10.25 <sup>b</sup>	2452.71±32.33 <sup>a</sup>	2465.41±36.06 <sup>a</sup>
Met	82.94±0.08 <sup>b</sup>	84.63±2.42 <sup>b</sup>	95.51±1.37 <sup>a</sup>
Cys	81.72±4.32 <sup>a</sup>	71.96±2.20 <sup>b</sup>	76.14±0.46 <sup>ab</sup>
Salty amino acids	164.66±4.40 <sup>b</sup>	156.59±1.31 <sup>c</sup>	171.65±1.30 <sup>a</sup>
Total	3296.27±5.77 <sup>b</sup>	3664.83±34.03 <sup>a</sup>	3637.62±53.12 <sup>a</sup>



**Fig. S1.** Relative abundance of bacteria (A) and fungi (B) at the phylum level. Relative abundance of bacteria (C) and fungi (D) at the genus level.