

# Supplementary Materials: Bio-Preservative Potential of Microorganisms Isolated from Red Grape Against Food Contaminant Fungi

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**Table S1.** Identification and quantification of the main VOC present in the CFS. Results as a percentage (%) of the VOC by dividing the area of each peak by the total area of the chromatogram peaks. Statistically significant differences for each fermentation are indicated with different letters ( $p < 0.05$ ). nd = not detected

VOCs	Samples									
	MRS	UTA1	UTA2	UTA3	UTA4	UTA5	UTA6	UTA7	UTA8	UTA9
<b>ALCOHOLS</b>	37.8 ± 3.1 <sup>a</sup>	16.6 ± 1.8 <sup>ab</sup>	13.3 ± 2.2 <sup>bcde</sup>	13.0 ± 0.6 <sup>bcde</sup>	8.7 ± 2.1 <sup>fg</sup>	12.3 ± 3.1 <sup>cdef</sup>	16.1 ± 0.6 <sup>abc</sup>	4.3 ± 0.4 <sup>ijk</sup>	8.4 ± 1.1 <sup>fgh</sup>	3.7 ± 0.1 <sup>ikl</sup>
Ethanol	nd	11.1 ± 0.3	8.4 ± 1.8	9.8 ± 0.1	8.7 ± 2.1	12.3 ± 3.1	12.9 ± 0.3	3.3 ± 0.3	8.4 ± 1.1	nd
2-Ethyl-1-hexanol	37.8 ± 3.1	5.4 ± 1.5	4.9 ± 0.4	3.2 ± 0.5	nd	nd	3.2 ± 0.3	1.0 ± 0.1	nd	3.7 ± 0.1
<b>ALDHEYDES</b>	27.8 ± 1.0 <sup>bcd</sup>	24.9 ± 5.0 <sup>bcdefg</sup>	15.8 ± 3.4 <sup>hij</sup>	19.3 ± 1.7 <sup>efghij</sup>	12.7 ± 1.1 <sup>j</sup>	17.7 ± 0.4 <sup>efghij</sup>	14.1 ± 2.9 <sup>ij</sup>	17.3 ± 1.3 <sup>ghij</sup>	21.2 ± 2.3 <sup>d efghi</sup>	23.6 ± 1.2 <sup>cdefgh</sup>
3-Methylbutanal	nd	7.8 ± 1.8	4.0 ± 0.9	5.1 ± 1.1	nd	nd	nd	9.7 ± 0.7	4.8 ± 0.4	6.5 ± 0.0
Benzaldehyde	13.0 ± 0.8	3.6 ± 1.7	2.8 ± 0.2	4.0 ± 0.4	4.2 ± 0.8	3.8 ± 0.1	5.5 ± 0.5	1.8 ± 0.2	5.2 ± 0.4	4.7 ± 0.7
Benzeneacetaldehyde	nd	12.6 ± 0.7	7.6 ± 1.5	8.4 ± 0.1	8.5 ± 0.3	12.5 ± 0.2	8.5 ± 2.4	5.7 ± 0.4	11.3 ± 1.5	12.5 ± 0.5
3-Methylbenzaldehyde	14.8 ± 0.3	0.8 ± 0.8	1.4 ± 0.7	1.8 ± 0.2	nd	1.5 ± 0.1	nd	nd	nd	nd
<b>PYRAZINES</b>	nd	19.5 ± 6.4 <sup>fg</sup>	27.9 ± 1.2 <sup>bcdefg</sup>	26.9 ± 2.3 <sup>cdefg</sup>	32.8 ± 1.3 <sup>abcd</sup>	30.1 ± 2.7 <sup>bcde</sup>	30.9 ± 5.4 <sup>abcd</sup>	10.0 ± 0.7 <sup>h</sup>	20.2 ± 3.6 <sup>fg</sup>	35.2 ± 2.1 <sup>abc</sup>
2,5-Dimethylpyrazine	nd	11.2 ± 2.9	18.6 ± 0.4	14.2 ± 0.1	21.3 ± 0.2	14.1 ± 0.5	15.6 ± 1.4	5.4 ± 0.1	10.6 ± 1.9	22.1 ± 0.3
2-Ethyl-6-methylpyrazine	nd	nd	1.2 ± 0.2	2.3 ± 0.3	3.9 ± 0.4	3.1 ± 0.4	2.1 ± 0.8	nd	nd	3.9 ± 1.4
Trimethylpyrazine	nd	nd	0.4 ± 0.1	0.3 ± 0.1	0.8 ± 0.3	0.5 ± 0.1	0.4 ± 0.0	nd	nd	nd
2-ethyl-3-methyl-Pyrazine	nd	nd	nd	0.2 ± 0.1	nd	nd	nd	nd	nd	nd
2-ethenyl-6-methyl-Pyrazine	nd	0.6 ± 0.1	0.4 ± 0.2	0.4 ± 0.0	0.3 ± 0.1	0.7 ± 0.3	0.7 ± 0.2	nd	nd	nd
3-Ethyl-2,5-dimethylpyrazine	nd	5.7 ± 2.1	5.6 ± 0.2	6.5 ± 0.8	4.6 ± 0.2	7.6 ± 0.5	8.1 ± 2.0	3.1 ± 0.4	6.7 ± 0.6	7.2 ± 0.2
2,6-diethyl-Pyrazine	nd	0.3 ± 0.0	nd	nd	0.8 ± 0.0	nd	nd	nd	nd	nd
2-ethyl-3,5-dimethyl-Pyrazine	nd	0.1 ± 0.0	0.3 ± 0.1	0.9 ± 0.4	nd	0.8 ± 0.2	nd	nd	nd	nd
2,5-Dimethyl-3-isopentylpyrazine	nd	1.6 ± 1.2	1.4 ± 0.0	2.1 ± 0.5	1.1 ± 0.1	3.3 ± 0.7	4.0 ± 0.9	1.6 ± 0.2	2.8 ± 1.1	2.0 ± 0.1
<b>OTHERS</b>	34.5 ± 0.7 <sup>defgh</sup>	39.0 ± 0.8 <sup>bcdefg</sup>	43.0 ± 4.3 <sup>bcde</sup>	40.7 ± 3.8 <sup>bcdef</sup>	45.8 ± 4.1 <sup>bcd</sup>	40.0 ± 3.2 <sup>bcdefg</sup>	38.9 ± 2.8 <sup>bcdefg</sup>	68.4 ± 1.6 <sup>a</sup>	50.2 ± 3.7 <sup>b</sup>	37.4 ± 3.2 <sup>cdefgh</sup>
Acetic acid	7.1 ± 0.3	27.5 ± 0.1	33.1 ± 2.1	27.5 ± 0.8	22.8 ± 1.0	23 ± 0.4	28.2 ± 0.7	65.3 ± 0.9	42.5 ± 2.8	28.0 ± 1.6
Ethyl acetate	nd	9.8 ± 0.2	5.8 ± 0.9	7.4 ± 0.9	18.2 ± 1.2	9.9 ± 1.0	5.6 ± 1.5	2.4 ± 0.7	7.7 ± 0.8	5.6 ± 1.2
Dimethyl trisulfide	nd	nd	nd	1.3 ± 0.2	1.0 ± 0.4	1.7 ± 0.5	1.3 ± 0.3	nd	nd	2.5 ± 0.4
2,3,5-trimethyl-Hexane	nd	nd	2.0 ± 0.4	1.8 ± 0.3	1.8 ± 0.4	1.7 ± 0.1	2.2 ± 0.1	0.6 ± 0.0	nd	nd
1,3-Di-tert-butylbenzene	nd	1.2 ± 0.2	0.8 ± 0.5	1.5 ± 0.2	1.3 ± 0.6	1.9 ± 0.0	1.7 ± 0.2	nd	nd	1.3 ± 0.1
2,4-Di-tert-butylphenol	27.4 ± 0.4	nd	nd	nd	nd	nd	nd	nd	nd	nd
(2,4-ditert-butylphenyl) 5-hydroxypentanoate	nd	0.3 ± 0.3	nd	nd	nd	0.8 ± 0.1	nd	nd	nd	nd

1,5-Diphenyl-2H-1,2,4-triazoline-3-thione	nd	nd	1.3 ± 0.4	1.3 ± 1.3	0.7 ± 0.5	1.0 ± 1.1	nd	nd	nd	nd
<b>VOCs</b>	<b>Samples</b>									
	<b>UTA10</b>	<b>UTA11</b>	<b>UTA12</b>	<b>UTA13</b>	<b>UTA14</b>	<b>UTA15</b>	<b>UTA16</b>	<b>UTA17</b>	<b>UTA18</b>	<b>UTA19</b>
<b>ALCOHOLS</b>	10.4 ± 1.9 <sup>defgh</sup>	8.6 ± 1.8 <sup>fgh</sup>	6.5 ± 0.2 <sup>hijk</sup>	17.8 ± 1.2 <sup>a</sup>	9.5 ± 0.1 <sup>efgh</sup>	16.3 ± 1.8 <sup>abc</sup>	6.6 ± 0.1 <sup>hijk</sup>	7.4 ± 0.5 <sup>ghij</sup>	7.5 ± 0.1 <sup>ghijk</sup>	3.7 ± 0.4 <sup>ijkl</sup>
Ethanol	7.8 ± 1.4	7.2 ± 1.8	nd	10.3 ± 0.7	nd	nd	6.6 ± 0.1	6.0 ± 0.3	7.5 ± 0.1	3.7 ± 0.4
3-methyl-1-Butanol	nd	nd	6.5 ± 0.2	7.5 ± 0.5	9.5 ± 0.1	9.7 ± 1.7	nd	nd	nd	nd
2-methyl-1-Butanol	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
2-Ethyl-1-hexanol	2.5 ± 0.6	nd	nd	nd	nd	6.6 ± 0.1	nd	1.5 ± 0.2	nd	nd
<b>ALDHEYDES</b>	20.9 ± 0.9 <sup>defghi</sup>	23 ± 2.9 <sup>cdefgh</sup>	29.8 ± 3.7 <sup>bcd</sup>	25.2 ± 2.4 <sup>bcdefg</sup>	32.7 ± 2.1 <sup>b</sup>	23.9 ± 4.0 <sup>bcdefg</sup>	41.2 ± 1.1 <sup>a</sup>	27.6 ± 1.6 <sup>bcde</sup>	25.9 ± 0.8 <sup>bcdef</sup>	30.5 ± 3.8 <sup>bc</sup>
3-Methylbutanal	8.0 ± 0.3	7.4 ± 0.8	8.5 ± 1.2	8.9 ± 1.2	11.9 ± 1.6	8.1 ± 1.7	8.6 ± 0.2	4.9 ± 0.2	9.2 ± 0.7	11.9 ± 2.4
Benzaldehyde	3.3 ± 0.3	2.8 ± 0.3	4 ± 1.3	3.3 ± 0.0	3.0 ± 0.1	3.6 ± 0.4	5.9 ± 0.2	3.7 ± 0.2	3.9 ± 0	4.6 ± 1.0
Benzeneacetaldehyde	9.7 ± 0.3	11.1 ± 1.5	14.7 ± 1.0	13 ± 1.2	17.8 ± 0.4	12.1 ± 1.9	16.6 ± 0.4	13.8 ± 1.1	12.8 ± 0.1	14 ± 0.4
3-Methylbenzaldehyde	nd	1.7 ± 0.3	2.6 ± 0.2	nd	nd	nd	5.2 ± 0.2	3.5 ± 0.1	nd	nd
5-Methyl-2-phenyl-2-hexenal	nd	nd	nd	nd	nd	nd	4.8 ± 0.1	1.8 ± 0.1	nd	nd
<b>PYRAZINES</b>	26.1 ± 1.5 <sup>cdefg</sup>	19.1 ± 1.5 <sup>gh</sup>	20.8 ± 2.7 <sup>efg</sup>	27.9 ± 4.4 <sup>bcdefg</sup>	27.7 ± 1.5 <sup>bcdefg</sup>	21.6 ± 1.8 <sup>efg</sup>	23.9 ± 0.8 <sup>defg</sup>	30.1 ± 1 <sup>bcde</sup>	34.8 ± 0.9 <sup>abc</sup>	40.3 ± 4.2 <sup>a</sup>
2,5-Dimethylpyrazine	17.4 ± 1.1	12.9 ± 0.6	14.3 ± 1.3	16.1 ± 1.8	20.8 ± 0.6	17.6 ± 0.9	8.5 ± 0.2	14.1 ± 0.5	16.5 ± 0.5	22.6 ± 2.4
2-Ethyl-6-methylpyrazine	1.9 ± 0.2	1.1 ± 0.2	nd	7.0 ± 1.0	nd	nd	nd	3.5 ± 0.1	nd	nd
3-Ethyl-2,5-dimethylpyrazine	5.0 ± 0.0	2.9 ± 0.4	4.4 ± 0.7	3.0 ± 1.0	4.7 ± 0.7	2.7 ± 0.5	6.3 ± 0.2	7.2 ± 0.2	12 ± 0.1	10.3 ± 1.2
2,6-diethyl-Pyrazine	nd	0.6 ± 0.0	nd	nd	nd	nd	nd	nd	nd	nd
2-ethyl-3,5-dimethyl-Pyrazine	nd	nd	nd	nd	nd	nd	nd	nd	nd	2.4 ± 0.4
2,6-Dimethyl-3(2-methyl-1-butyl)pyrazine	nd	nd	nd	nd	nd	nd	0.9 ± 0.0	0.6 ± 0.1	0.8 ± 0	0.7 ± 0.2
2,5-Dimethyl-3-isopentylpyrazine	1.9 ± 0.1	1.6 ± 0.3	2.2 ± 0.6	1.9 ± 0.6	2.2 ± 0.1	1.3 ± 0.4	8.3 ± 0.4	4.7 ± 0.2	5.5 ± 0.3	4.3 ± 0.1
<b>OTHERS</b>	42.6 ± 4.0 <sup>bcde</sup>	49.3 ± 2.9 <sup>bcd</sup>	42.9 ± 6.2 <sup>bcde</sup>	29.1 ± 2.0 <sup>fgh</sup>	30.1 ± 3.1 <sup>fgh</sup>	38.2 ± 3.3 <sup>bcdefg</sup>	28.4 ± 0.9 <sup>gh</sup>	34.9 ± 0.9 <sup>defgh</sup>	31.8 ± 0.9 <sup>efgh</sup>	25.5 ± 4.1 <sup>h</sup>
Acetic acid	28.4 ± 2.0	21.6 ± 0.7	23.3 ± 1.9	18.3 ± 0.9	20.0 ± 2.1	26.2 ± 2.1	12.9 ± 0.3	17.5 ± 0.2	21.9 ± 0.6	13.4 ± 2.3
Ethyl acetate	9.6 ± 1.0	4.9 ± 0.0	nd	3.2 ± 0.1	nd	3.9 ± 0.7	nd	3.8 ± 0.1	nd	nd
1,1-dimethyl- Cyclopropane	nd	10.3 ± 0.7	nd	nd	nd	nd	nd	nd	nd	nd
Dimethyl trisulfide	2.3 ± 0.2	5.1 ± 0.6	8.1 ± 1.7	5.6 ± 0.6	7.6 ± 0.5	6.2 ± 0.2	3.0 ± 0.0	4.7 ± 0.4	4.0 ± 0.2	4.5 ± 0.6
4-ethyl-Decane	nd	nd	nd	nd	nd	nd	nd	nd	nd	2.1 ± 0.5
Ethanone, 1-(1H-pyrrol-2-yl)-	nd	1.6 ± 0.2	2.3 ± 0.5	0.8 ± 0.1	1.0 ± 0.5	2.0 ± 0.3	3.6 ± 0.1	3.5 ± 0.2	nd	nd
3,6-dimethyl-Decane	nd	nd	nd	nd	nd	nd	nd	nd	nd	2.0 ± 0.3
2,3,5-trimethyl-Hexane	nd	1.4 ± 0.0	2.6 ± 0.6	nd	nd	nd	nd	nd	nd	nd
1,3-Di-tert-butylbenzene	nd	2.6 ± 0.1	4.7 ± 0.8	nd	nd	nd	3.9 ± 0.1	2.1 ± 0.1	3.8 ± 0.1	nd
2,4-Di-tert-butylphenol	nd	nd	nd	nd	nd	nd	5.0 ± 0.4	3.3 ± 0.0	2.0 ± 0.0	3.5 ± 0.4
(2,4-ditert-butylphenyl) 5-hydroxypentanoate	0.9 ± 0.5	0.7 ± 0.1	nd	nd	nd	nd	nd	nd	nd	nd
1,5-Diphenyl-2H-1,2,4-triazoline-3-thione	1.4 ± 0.3	1.1 ± 0.4	1.9 ± 0.5	1.2 ± 0.2	1.6 ± 0.1	nd	nd	nd	nd	nd
<b>VOCs</b>	<b>Samples</b>									
	<b>UTA20</b>	<b>UB5</b>	<b>UB6</b>	<b>UB7</b>	<b>UB8</b>	<b>UBC1</b>	<b>UTC6</b>	<b>UT5</b>	<b>VBC9</b>	
<b>ALCOHOLS</b>	9.4 ± 0.9 <sup>efgh</sup>	3.6 ± 0.2 <sup>kl</sup>	4.2 ± 0.9 <sup>jk</sup>	3.2 ± 0.2 <sup>kl</sup>	11 ± 2.2 <sup>fgh</sup>	nd	13.6 ± 0.9 <sup>jk</sup>	nd	9.9 ± 1.4 <sup>abcd</sup>	

Ethanol	4.1 ± 0.6	nd	nd	nd	6.0 ± 1.1	nd	8.8 ± 0.2	nd	3.4 ± 0.4
3-methyl-1-Butanol	5.2 ± 0.3	3.6 ± 0.2	nd	nd	5.0 ± 1.1	nd	4.8 ± 0.7	nd	3.9 ± 0.9
2-methyl-1-Butanol	nd	nd	nd	nd	nd	nd	nd	nd	2.7 ± 0.2
2-Ethyl-1-hexanol	nd	nd	4.2 ± 0.9	3.2 ± 0.2	nd	nd	nd	nd	nd
<b>ALDHEYDES</b>	26.1 ± 1.9 <sup>bcdef</sup>	26.6 ± 1.4 <sup>bcdef</sup>	31.0 ± 0.9 <sup>bc</sup>	26.5 ± 3.8 <sup>bcdef</sup>	19.4 ± 2.4 <sup>defghi</sup>	31.2 ± 2.5 <sup>bc</sup>	24.0 ± 2.1 <sup>bcdefg</sup>	24.5 ± 3.9 <sup>bcdefg</sup>	29 ± 3.2 <sup>bcd</sup>
3-Methylbutanal	5.9 ± 0.1	6.7 ± 0.4	18.5 ± 0.5	9.7 ± 0.8	nd	8.5 ± 0.7	4.2 ± 0.9	6.2 ± 1.6	4.1 ± 0.3
2-Methylbutanal	nd	nd	nd	nd	nd	nd	nd	nd	1.9 ± 0.1
Benzaldehyde	4.6 ± 0.4	2.0 ± 0.0	nd	nd	5.2 ± 0.4	nd	3.2 ± 0.0	nd	4.2 ± 0.6
Benzeneacetaldehyde	15.6 ± 1.3	8.5 ± 0.2	7.3 ± 0.3	16.8 ± 2.9	9.6 ± 0.5	9.9 ± 0.2	9.2 ± 0.2	7.6 ± 0.5	10.8 ± 0.7
3-Methylbenzaldehyde	nd	9.4 ± 0.8	5.2 ± 0.0	nd	4.7 ± 1.4	12.8 ± 1.5	4.5 ± 0.1	10.7 ± 1.8	4.6 ± 0.6
5-Methyl-2-phenyl-2-hexenal	nd	nd	nd	nd	nd	nd	2.9 ± 0.9	nd	nd
<b>PYRAZINES</b>	36.8 ± 2.8 <sup>ab</sup>	33.0 ± 1.6 <sup>abcd</sup>	31.5 ± 3.2 <sup>abcd</sup>	19.8 ± 1.1 <sup>fg</sup>	20.6 ± 1.1 <sup>efg</sup>	29.2 ± 5.3 <sup>bcdef</sup>	19.3 ± 1.1 <sup>gh</sup>	31.6 ± 3.3 <sup>abcd</sup>	24.9 ± 3.5 <sup>defg</sup>
2,5-Dimethylpyrazine	22.7 ± 0.6	20.2 ± 0.6	31.5 ± 3.2	16.8 ± 1.0	12.6 ± 0.6	23.7 ± 3.7	7.9 ± 0.1	17.6 ± 0.6	10.1 ± 0.9
2-Ethyl-6-methylpyrazine	nd	3.3 ± 0.4	nd	nd	nd	4.2 ± 1	nd	3.3 ± 0.8	nd
Trimethylpyrazine	nd	1.8 ± 0.1	nd	nd	nd	nd	nd	nd	nd
3-Ethyl-2,5-dimethylpyrazine	7.2 ± 1.4	2.3 ± 0.3	nd	1.8 ± 0.1	4.5 ± 0.3	nd	3.4 ± 0.5	3.5 ± 0.7	4.6 ± 0.1
2,6-diethyl-Pyrazine	nd	nd	nd	nd	nd	nd	2.2 ± 0.3	nd	nd
2-ethyl-3,5-dimethyl-Pyrazine	nd	nd	nd	nd	nd	nd	nd	nd	3.1 ± 1.6
2-Isoamyl-6-methylpyrazine	nd	1.5 ± 0.1	nd	nd	nd	nd	nd	nd	nd
2,6-Dimethyl-3(2-methyl-1-butyl)pyrazine	0.7 ± 0.2	0.8 ± 0.0	nd	nd	0.4 ± 0.0	1.3 ± 0.7	nd	1.3 ± 0.7	0.8 ± 0.1
2,5-Dimethyl-3-isopentylpyrazine	6.3 ± 0.6	nd	nd	1.2 ± 0.0	3.1 ± 0.1	nd	5.8 ± 0.3	3.5 ± 0.2	6.2 ± 0.8
2-butyl-3,5-dimethyl-Pyrazine	nd	3.2 ± 0.1	nd	nd	nd	nd	nd	2.5 ± 0.3	nd
<b>OTHERS</b>	27.8 ± 3.3 <sup>gh</sup>	36.8 ± 2.4 <sup>cdefgh</sup>	33.4 ± 2.9 <sup>efgh</sup>	50.5 ± 3.9 <sup>b</sup>	49 ± 5.9 <sup>bc</sup>	39.5 ± 2.6 <sup>bcdefg</sup>	43.1 ± 3.1 <sup>bcde</sup>	44 ± 3.7 <sup>bcde</sup>	36.2 ± 4.2 <sup>defgh</sup>
Acetic acid	13.2 ± 0.9	8 ± 0.4	8.9 ± 0.7	25.1 ± 0.8	21.8 ± 1.4	5.1 ± 1.0	14.3 ± 0.3	5.5 ± 0.9	11.0 ± 1.5
Ethyl acetate	5.1 ± 1.3	nd	nd	5.4 ± 0.1	8.1 ± 1.5	nd	6.5 ± 1.4	nd	3.3 ± 0.2
1,1-dimethyl- Cyclopropane	nd	nd	nd	12.4 ± 0.7	nd	nd	nd	nd	nd
Dimethyl trisulfide	3.6 ± 0.9	2.6 ± 0.0	nd	7.7 ± 2.3	5.7 ± 1.5	nd	2.3 ± 0.2	nd	2.7 ± 0.2
4-ethyl-Decane	nd	nd	nd	nd	2 ± 0.3	nd	2.3 ± 0.2	nd	2.3 ± 0.3
Ethanone, 1-(1H-pyrrol-2-yl)-	nd	3.3 ± 0.0	nd	nd	4.6 ± 0.1	nd	3.5 ± 0.1	nd	2.5 ± 0.3
3,6-dimethyl-Decane	nd	nd	nd	nd	1.8 ± 0.1	nd	2.6 ± 0.1	nd	1.4 ± 0.2
5-methyl-Undecane	nd	nd	nd	nd	nd	nd	nd	nd	5.0 ± 0.4
1,3-Di-tert-butylbenzene	5.9 ± 0.1	21.1 ± 1.9	24.5 ± 2.2	nd	1.9 ± 0	34.4 ± 1.6	7.0 ± 0.2	38.5 ± 2.9	5.1 ± 0.5
2,4-Di-tert-butylphenol	nd	1.7 ± 0.1	nd	nd	2.0 ± 0.7	nd	2.3 ± 0.1	nd	2.7 ± 0.6

1,5-Diphenyl-2H- 1,2,4-triazoline-3- thione	nd	nd	nd	nd	nd	nd	2.4 ± 0.4	nd	nd
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