Artigo Publicado na Revista
Food Research International
Vol.123, 2019

Metabolic diversity conveyed by the process leading to glutathione accumulation in inactivated dry yeast: A synthetic media study

Florian Bahut [a], Youzhong Liu [a], Rémy Romanet [a], Christian Coelho [a], Nathalie Sieczkowski [b], Hervé Alexandre [a], Philippe Schmitt-Kopplin [a], Maria Nikolantonaki [a], Régis D. Gougeon [a]

[a] Univ. Bourgogne Franche-Comté, AgroSup Dijon, PAM UMR A 02.102, Institut Universitaire de la Vigne et du Vin – Jules Guyot, F-21000 Dijon, France

[b] Lallemand SAS, 19 rue des Briquetiers, BP 59, 31 702 Blagnac, France

[c] Research Unit Analytical BioGeoChemistry, Helmholtz Zentrum Muenchen, 85764 Neuherberg, Germany

[d] Analytical Food Chemistry, Technische Universität München, Alte Akademie 10, 85354 Freising, Germany

Received 21 July 2018, Revised 23 April 2019, Accepted 5 June 2019, Available online 7 June 2019.

Highlights

- Combined MS analyses for a comprehensive characterization of GSH enriched IDY extractable fractions.
- Hundreds of peptides associated with the glutathione enrichment process.
- 16 identified markers not yet associated with glutathione enrichment.

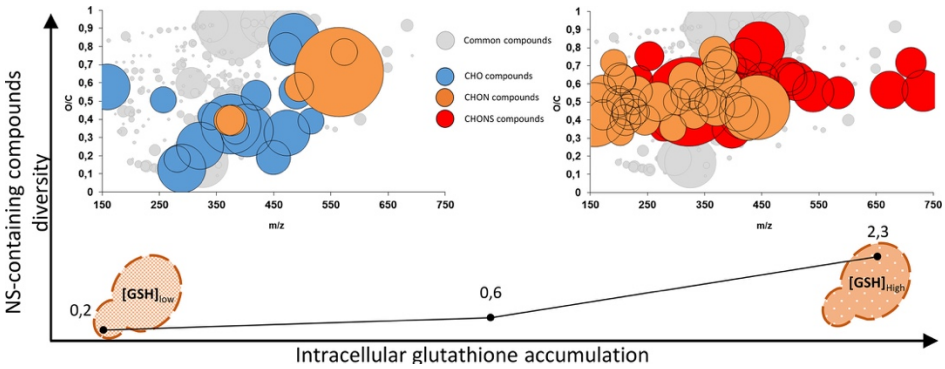
Abstract:

Glutathione-rich inactivated dry yeasts (GSH-IDY) are purported to accumulate glutathione intracellularly and then released into the must. Glutathione is beneficial for wine quality, but research has highlighted that GSH-IDYs have a synergic antioxidant effect similar to that of molecular GSH. Combination of negative mode ultra-high-resolution Fourrier-Transform Ion-Cyclotron-Resonance Mass Spectrometry ((−)FT-ICR-MS), ultra-high-performance liquid chromatography coupled to a Quadrupole-Time of Flight mass spectrometer (UHPLC-Q-ToF-MS) and HPLC/Diode Detector Array (DAD)-Fluorescence spectroscopy was applied to three inactivated dry yeasts soluble fractions, with increasing intracellular glutathione concentration, in order to explore the chemical diversity released in different synthetic media.

Using the mean of size exclusion chromatography/DAD and fluorescence detection we report than most of the signals detected were below the 5–75 kDa-calibrated region of the chromatogram, indicating that most of the soluble protein fraction is composed of low molecular weight soluble peptides. In light of these results, high-resolution mass spectrometry was used to scan and annotate the low molecular weight compounds from 50 to 1500 Da and showed that GSH level of enrichment in IDYs was correlated to a discriminant chemical diversity of the corresponding soluble fractions. Our results clearly show an impact of the GSH accumulation process not only visible on the glutathione itself, but also on the global diversity of compounds.

Within the 1674 ions detected by (−)FT-ICR-MS, the ratio of annotated elemental formulas containing carbon, hydrogen, oxygen, nitrogen and sulfur (CHONS) to annotated elemental formulas containing carbon, hydrogen, oxygen (CHO) increased from 0.2 to 2.1 with the increasing levels of IDYs GSH content and 36 unique CHONS annotated formulas were unique to the IDY with the highest concentration of GSH. Amongst the 1674 detected ions 193 were annotated as potential peptides (from 2 to 5 residues), 61 ions were annotated as unique amino acid combinations and 46% of which being significantly more intense in GSH-rich IDY. Thus, the process leading to the accumulation of glutathione also involves other metabolic pathways which contribute to an increase in CHONS containing compounds potentially released in wine, notably peptides.

Graphical abstract



Keywords

Mass spectrometry; Wine; Oenology; Untargeted analysis

Chemical compounds studied in this article

Glutathione (PubChem CID: 124886)
Leucyl-arginine (PubChem CID: 3800205)
Leucyl-lysine (PubChem CID: 14299197)
Adenosine (PubChem CID: 60961)
Glutamyl-cysteine (PubChem CID: 123938)
Pantothenic acid (PubChem CID: 6613)
Cysteinyl-glycine (PubChem CID: 439498)
Pipecolic acid (PubChem CID: 439227)
Homocitric acid (PubChem CID: 5460287)
Deoxy-methylthioadenosine (PubChem CID: 439176)

Abbreviations

IDY - inactivated dry yeast
GSH - glutathione
MS - mass spectrometry
WSF - water soluble fraction
MWSF - model wine soluble fraction
MSF - methanol soluble fraction

GPC - gel permeation chromatography
HPLC - high pressure liquid chromatography
DAD - diode array detector
LMW - low molecular weight
UHPLC-Q-ToF-MS - Ultra-High-Performance Liquid chromatography triple quadrupole time of flight mass spectrometry
RP-LC - reversed phase liquid chromatography
(−)FT-ICR-MS - Negative mode Fourier-transform ion-cyclotron-resonance mass spectrometry
S/N - Signal/Noise
kDa - kilo Dalton
MAAC - Multiple Amino Acid Combination
UAAC - Unique Amino Acid Combination
CHO - Carbon-Hydrogen-Oxygen
CHON - Carbon-Hydrogen-Oxygen-Nitrogen
CHONS - Carbon-Hydrogen-Oxygen-Nitrogen-Sulfur

Contacte-nos para informação adicional sobre este artigo (proenol@proenol.com)