CoolWine. Model-guided evolution for balanced attenuation of wine ethanol content by developing non-GMO yeast strains and communities

Ramon Gonzalez, ICVV (CSIC, Universidad de La Rioja, Gobierno de La Rioja), Logroño, Spain; Albert Mas, Universitat Rovira i Virgili, Tarragona, Spain; Eivind Almaas, Norwegian University of Science and Technology, Trondheim, Norway; Esperanza Tomás, Bodegas Roda S.A., Haro, España; Jonas Warringer, University of Gothenburg, Gothenburg, Sweden; Kiran R. Patil, European Molecular Biology Laboratory, Heidelberg, Germany

Biotechnological problem

Increasing temperature in the European wine producing regions is having a negative impact on this key sector. Climate change results in a lack of balance between technological and phenolic ripening of wine grapes and, therefore, alcohol increase in wines. This trend is of great concern for the European wine industry because it has a negative impact on wine quality, becomes a hurdle for international trade, and jeopardizes compatibility of moderate wine consumption with a healthy lifestyle.

CoolWine Strategy

We propose a two-track strategy to reduce ethanol yield during wine fermentation. Track 1: model-guided adaptive laboratory evolution (ALE) of wine yeasts. Track 2: model-guided assembly of improved communities including *S. cerevisiae* as well as alternative yeast species.

Scientific approach

We have previously used microbial consortia and oxygenated fermentations to successfully reduce ethanol content of wines. Currently, several companies and research groups are also trying to follow this path, thus endorsing the technological and commercial validity of the approach. Although the current results are encouraging, we have also identified some bottlenecks (e.g. increased acetate production, which is harmful for wine quality). We will tackle both applied and basic scientific challenges, to overcome these hindrances.

For developing improved wine yeasts through model-guided ALE, currently available metabolic models and computational tools will be improved to account for data concerning respiration/fermentation balance and acetic acid production.

Computational models will be further informed by experimental data from different yeast mutants. In terms of the community models, we will identify metabolic pathways to be positively or negatively selected for in each species. This will allow us to develop microbial consortia suitable for alcohol level reduction. We will then run massive-scale ALE to explore a number of experimental conditions, and to cope with the stochastic nature of spontaneous genetic mutation.

Impact

The companies involved in this project have clearly identified their consumers' demand for solutions to high alcohol content. The technological steps and scientific approaches used in the project are devised to be very close to the actual production conditions. The strains and communities developed will be tested at commercially relevant scale. The contribution of the companies will be decisive to reach relevant results. They have a strong position in their cognate sectors, and a long culture of research and innovation.

Production of wines with reduced ethanol content using GMO-free solutions will strengthen the market position of European wines. We also expect CoolWine outcomes to contribute to healthier moderate wine consumption.

To ensure the highest social impact for this project, we have included a specific work package to channel the contribution of social scientist to CoolWine. They will contribute to modulate biotechnological targets, and develop a properly designed communication strategy.