



HAL
open science

Design and mathematical optimization of multi-strain ecosystems in winery

Sahar El Aida, Olivier Harle, Jean-Roch Mouret, Alain Rapaport, Thibault Nidelet

► **To cite this version:**

Sahar El Aida, Olivier Harle, Jean-Roch Mouret, Alain Rapaport, Thibault Nidelet. Design and mathematical optimization of multi-strain ecosystems in winery. MicrobiOccitanie 2019, Feb 2019, Montpellier, France. hal-02901337

HAL Id: hal-02901337

<https://hal.inrae.fr/hal-02901337>

Submitted on 17 Jul 2020

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Design and mathematical optimization of multi-strain ecosystems in winery

Sahar El'Aida¹, Olivier Harle², Jean-Roch Mouret¹, Alain Rapaport³, Thibault Nidelet¹

1 : SPO, Univ Montpellier, INRA, Montpellier SupAgro, Montpellier, France

2 : STLO, INRA, Agrocampus Ouest, Rennes, France

3: MISTEA, Univ Montpellier, INRA, Montpellier SupAgro, Montpellier, France

* Corresponding Author: thibault.nidelet@inra.fr

For food processing, fermentation by microorganisms allows food preservation and production of several fermented products, among the most consumed are bread, cheese, beer and wine. In all these anthropic environments, microbes form communities where individual microorganisms interact in various ways such as competition, predation, commensalism or mutualism that may have a tremendous effect on the final product quality. Exploiting these interactions by ecological engineering (by choosing the good partners in the good proportions) appears to be a promising strategy for improving fermented food. However, it demands a profound understanding of the interaction's mechanisms and an exponential number of experiments to assess all possible microbes combination. To meet these challenges in winery, we choose to guide our ecological designs by a mathematical model simulating the microbial and metabolic dynamics of the oenological fermentation. We perform a deep phenotyping of fermentation driven by different yeast-yeast combination that gives us the necessary information to build a mathematical model (of ordinary differential equations) that simulate the dynamic of mixed cultures from isolated cultures data. With this model, we test different inoculation protocols (which strain/species, in what proportion and at which time) and evaluate their performance for maximizing different functional traits.

Oenology, fermentation, yeast-yeast interactions, population dynamics, non-saccharomyces species, ecological engineering, microbiology, wine.