BIOTECHNOLOGICAL IMPROVEMENTS IN WINE PRODUCTION: genetically modified yeasts, *Saccharomyces cerevisiae*

Camila Sánchez Retuerta
DEGREE IN SCIENCE AND FOOD TECHNOLOGY, AUTONOMOUS UNIVERSITY OF BARCELONA

INTRODUCTION: The genetic improvement of industrial wine strains is now based on genetic engineering, the technology where just one characteristic of a gene can be modified with precision without affecting other desirable properties.

Impressive progress has been made, specially, in *Saccharomyces cerevisiae*. The principal targets of improvement fall into four categories: Fermentation performance, processing, organoleptic characteristics and wholesomeness of the product.

This technology is enabling the development of a new generation of specialized yeast strains, with new more suitable characteristics for winemaking.

THE PURPOSE OF THIS PAPER IS: to review selected examples of the different applications of yeast genetic engineering in the fields of winemaking.

FERMENTATION PERFORMANCE

Desiccation tolerance by accumulating trehalose

Genetic engineering: Deletion of genes *ATH1* and *NTH1*. Deletion of the *TPS1* gene.

ATH1 and ***NTH1*** are involved in **trehalose degradation; *TPS1*** is involved in its **synthesis**.

Trehalose acts as a **protective molecule** against desiccation.

One study demonstrated that the **deletion** of genes ***ATH1*** and ***NTH1***, improve yeast cells viability after dehydration.

However, in other study**, with the deletion of the *TPS1* gene,** the strains didn't produce trehalose, but they were able to tolerate desiccation.

Is there a **consistent relationship** between **trehalose** and **desiccation tolerance**?

PROCESSING

Regulated expression of the *FLO*-genes to facilitate clarification

Genetic engineering: Regulated expression of *FLO1* under control of the HSP30 promoter

it is necessary to **regulate gene expression** so that **flocculation occurs** during the **stationary phase** at the **end** of **fermentation.**

It is possible by **changing** the **native promoter** of *FLO1* **by** the ***HSP30*** promoter.

ORGANOLEPTIC CHARACTERISTICS

The "body" of a wine improves by increasing glycerol.

Genetic engineering: Overexpression of the *GDP1* gene and deletion of the *ALD6* gene

GDP1 is involved in glycerol synthesis.

Glycerol contributes to smoothness and overall body of a wine. An **overproduction** leads to a decreased ethanol yield.

***GDP1* overexpression** results in an increased production of acetate (side effect).

The **deletion** of ***ALD6*** results in a substantially lower acetate yield.

WINE WHOLESOMENESS

Decreased ethyl carbamate by decreasing urea formation

Genetic engineering: Overexpression of the *DUR1,2* gene

DUR1,2 encodes urea amidolyase, which catalyzes the degradation of urea.

Urea is the major precursor of **ethyl carbamate** in wine, which is a **carcinogen.**

***DUR1,2* overexpression** results in a decreased production of urea.

CONCLUSIONS:

- The use of modern biotechnology in wine yeasts is currently a powerful tool for improving the process of winemaking, and *Saccharomyces cerevisiae* is an outstanding model organism for applied research.
- But there are limitations in this kind of organisms (OGM) or its derived products such as byproducts formation, legislation and consumer perception.