Biotechnological Improvement in Wine

The Use of Genetically Modified Organisms to Obtain Healthier Wines

Introduction

Research on organisms genetically modified have been proven to be a valuable tool for improving food quality and become a great advantatge for winemakers.

At the same time, it has managed to meet the demands of consumers in order to offer healthy products. In the wine industry, genetic engineering work is being done to reduce the amount of toxics and increase beneficial compounds in wine

Objectives

The objectives of this study are as follows:

1. To comprehensively understand the different **genetic engineering tools** in the wine industry to obtain healthier wines.
2. To **identify** the toxic compounds produced during the wine making process and identify those substances that confer human health benefits in wine.
3. To evaluate the effects of using GMOs of the characteristics and quality of the final product.

GMO's for Producing Healthier Wines

The ML01 strain: designed to reduce the content of Biogenic Amines in wine

- Achivied by the expression of the **mae1 gene** from *S. pombe* and the **mleA gene** from *O. oenii* in *S. cerevisiae.*
- The mae1 gene condes the **transporter of malate** into the yeast cells and the mleA gene encodes the **malolactic enzyme**.

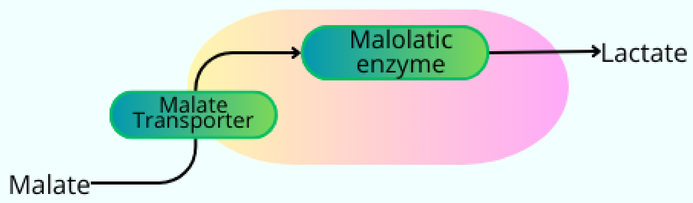

Fig 1. Transport and conversion of malate into lactate

- In this way *S. cerevisiae* is able to simultaneously carry out **alcoholic fermentation** and **malolactic fermentation** and avoids the growth of undesirable acid lactic bacteria responsible for producing biogenic amines in wine .

Increasing the Resveratrol content in wine

- By expressing *Nicotania tabacum's* **4CL gene** and the **STS gene** of *Vitis vinifera* in *S. cerevisiae.*
- Both genes are responsibles for producing resveratrol in plants, by the **phenylpropanoid pathway.**
- **Resveratrol** is a natural polyphenol present in grapes, multiple health benefits such as antioxidant and anti-inflammatory compound.

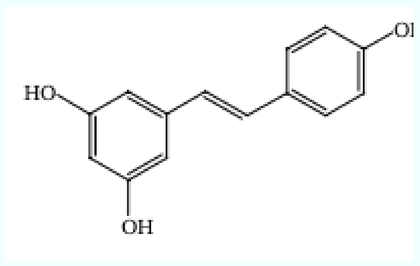

Fig 2. Chemical structure of Resveratrol

- This technique transforms the aminoacids Phe and Tyr present in must in resveratrol to 5,8mg/L.

Reducing the Content of EthylCarbamate in wine by Reducing and Minimizing Urea levels

- Ethylcarbamate, which is considered genotoxic and possible carcinogen, is derived from urea and ethanol.
- **Eliminating** the CAR1 gene or by the **overexpression** of DUR1,2 gene both responsible for metabolizing urea in *S. cerevisiae*
- Reduces the EthylCarbamate content by 74%.
- The CAR1 gene encodes the enzyme arginase, whereas the DUR1,2 gene condes the enzyme urea amidoliase.

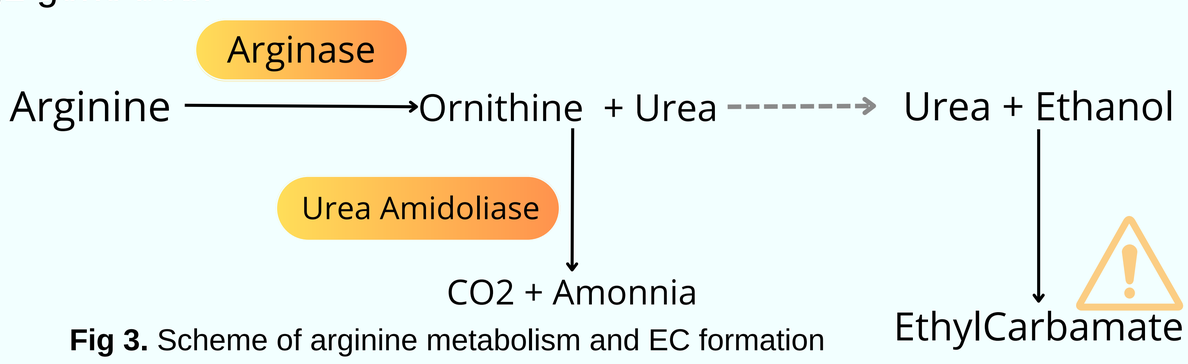

Fig 3. Scheme of arginine metabolism and EC formation

Conclusions

Recombinant DNA techinque has signifivantly advanced the production of food and drinks with enhanced health.
In winemaking, this tool has focused on modifying the genome of *S. cerevisiae* to be the organism for excellence uused in wine production and in most alcoholic beverages.Yet, it is a technique that faces limitations, particulary in legal terms and consumer acceptance.
Further research must be done to improve the production of genetically modified organisms applied to the food industry.

Husnik, J.I., Volschenk, H., Bauer, J., Colavizza, D., Luo, Z., van Vuuren, H.J.J., 2006b. Metabolic engineering of malolactic wine yeast. Metab Eng 8, 315–323. https://doi.org/10.1016/j.ymben.2006.02.003
Guo, X.W., Li, Y.Z., Guo, J., Wang, Q., Huang, S.Y., Chen, Y.F., Du, L.P., Xiao, D.G., 2016. Reduced production of ethyl carbamate for wine fermentation by deleting CAR1 in Saccharomyces cerevisiae. J Ind Microbiol Biotechnol 43, 671–679. https://doi.org/10.1007/s10295-016-1737-7
Wu, D., Li, X., Lu, J., Chen, J., Zhang, L., Xie, G., 2015. Constitutive expression of the DUR1,2 gene in an industrial yeast strain to minimize ethyl carbamate production during Chinese rice wine fermentation. FEMS Microbiol Lett 363. https://doi.org/10.1093/femsle/fnv214
Beekwilder, J., Wolswinkel, R., Jonker, H., Hall, R., De Rie Vos, C.H., Bovy, A., 2006. Production of resveratrol in recombinant microorganisms. Appl Environ Microbiol 72, 5670–5672. https://doi.org/10.1128/AEM.00609-06

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