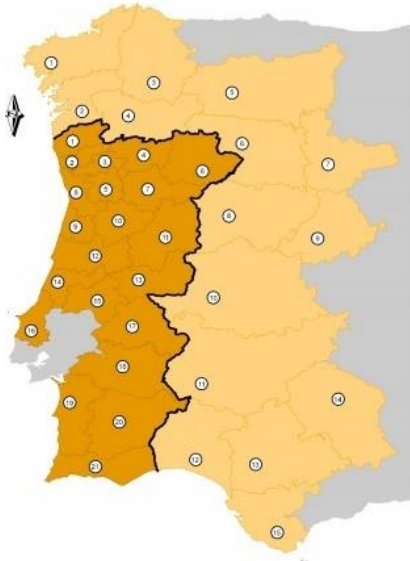


# Winery by-products as feedstocks for bioprocesses

## Project BIOVINO

**M. Hijosa-Valsero, A.I. Paniagua-García, R. Díez-Antolínez**

# Project BIOVINO



Interreg V-A España-Portugal  
(POCTEP) 2014-2020  
0688\_BIOVINO\_6\_E

**Execution period:**  
January 2018-December 2022

## Project objectives:

To lay the technical basis for promoting the establishment of multiproduct biorefineries which use wine industry by-products as feedstocks.

## Partners



INSTITUTO  
TECNOLÓGICO  
AGRARIO



universidad  
de león



universidade  
de aveiro

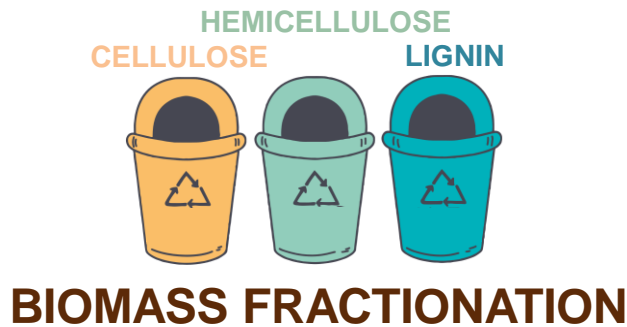
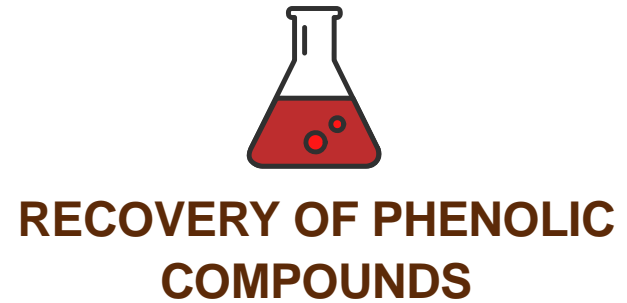
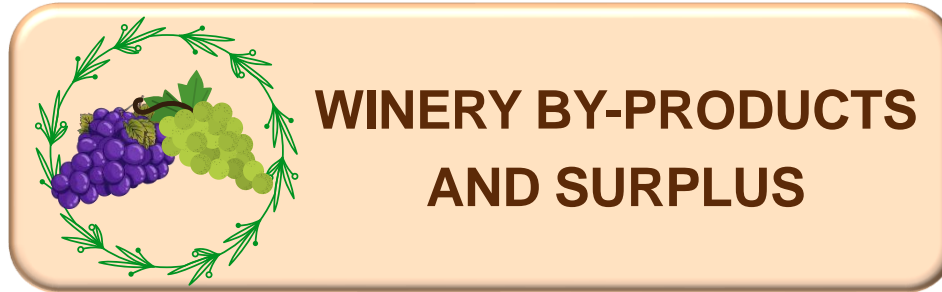


Universidade do Minho



**BLC3**  
CAMPUS  
DE TECNOLOGIA  
E INOVAÇÃO

# Tasks of BIOVINO



# Targeted bioproducts

## Polyols

Erythritol – Xylitol –  
Mannitol



## Organic acids

Lactic acid –  
Succinic acid



## Biocides

Plant protection



## Energy

Biogas –  
Biohydrogen



## Antioxidants

Polyphenols –  
Resveratrol –  
Anthocyanins



WINERY BY-PRODUCTS



WINERY SURPLUS



## Alcohols

Ethanol – Butanol



## Bioplastics

Polyhydroxyalkanoates  
(PHA)

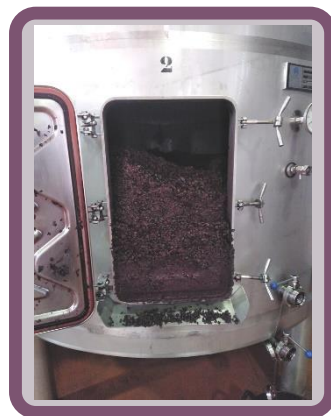


## Polymers

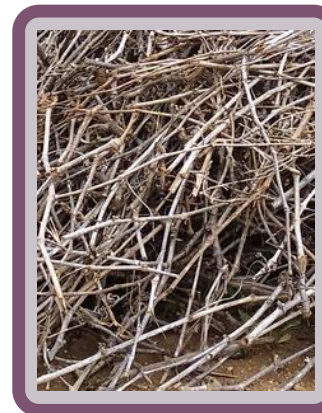
Cellulose – Lignin

# Main winery by-products

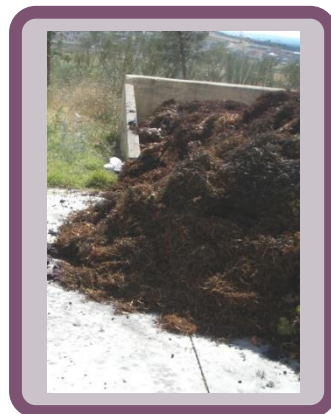
**Grape pomace/marc:**  
Solid waste from grape pressing.



**Vine shoots:**  
Woody wastes from vine pruning.










**Grape stalks:**  
Woody part of the bunch of grapes, obtained during destemming.



**Wine lees:**  
Liquid and viscous waste composed of materials and yeasts decanted during wine fermentation.



# Main winery by-products

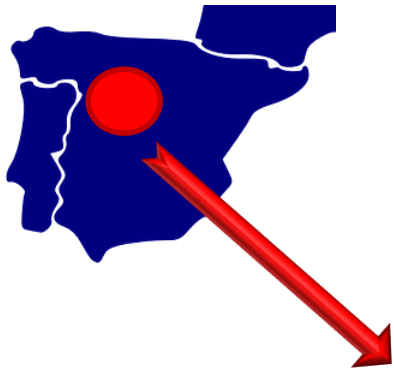
Feedstock	By-product	
<p>100 kg grape processed</p> 	74.5 kg wine	
	4 kg grape stalks	
	20 kg grape marc	
	1.5 kg wine lees	
<p>1 ha vineyard</p> 	3.05 t vine shoots (espalier)	
	1.70 t vine shoots (cup-shape)	

Botelho et al., 2018. *Grapes and wines: Advances in production, processing, analysis and valorization* (pp. 325-336).

Proyecto POCTEP MOV BIO. [https://movbio.eu/wp-content/uploads/2019/07/Potencial\\_Biomasa\\_Poda\\_CyL\\_Jose\\_Rubio\\_ITACYL-1.pdf](https://movbio.eu/wp-content/uploads/2019/07/Potencial_Biomasa_Poda_CyL_Jose_Rubio_ITACYL-1.pdf).

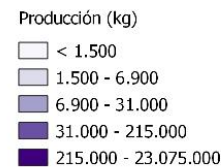
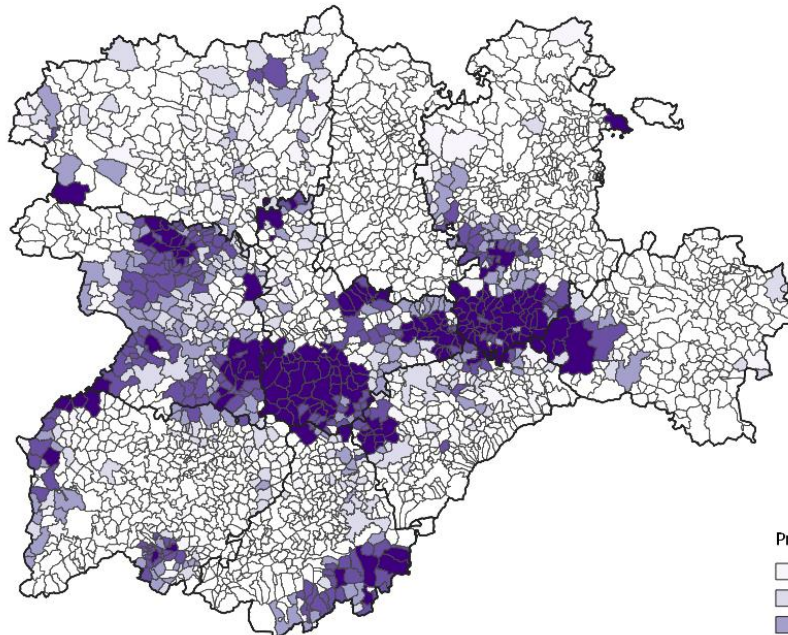
Spigno et al., 2017. *Handbook of Grape Processing By-Products* (pp. 1-27).

# Main winery by-products



	Portugal	Spain
<b>Vineyards (ha)</b>	192,029 (IVV, 2021)	930,889 (MAPA, 2021)
<b>Wine (ML)</b>	642 (IVV, 2020)	3,700 (MAPA, 2021)

Estimated grape production in Castile and Leon Campaign 2019




79,009 ha vineyard





	Tons
<b>Grapes</b>	339,231
<b>Vine shoots</b>	165,699
<b>Grape marc</b>	67,846
<b>Grape stalk</b>	13,569
<b>Wine lees</b>	5,088

# Composition of winery by-products and surplus



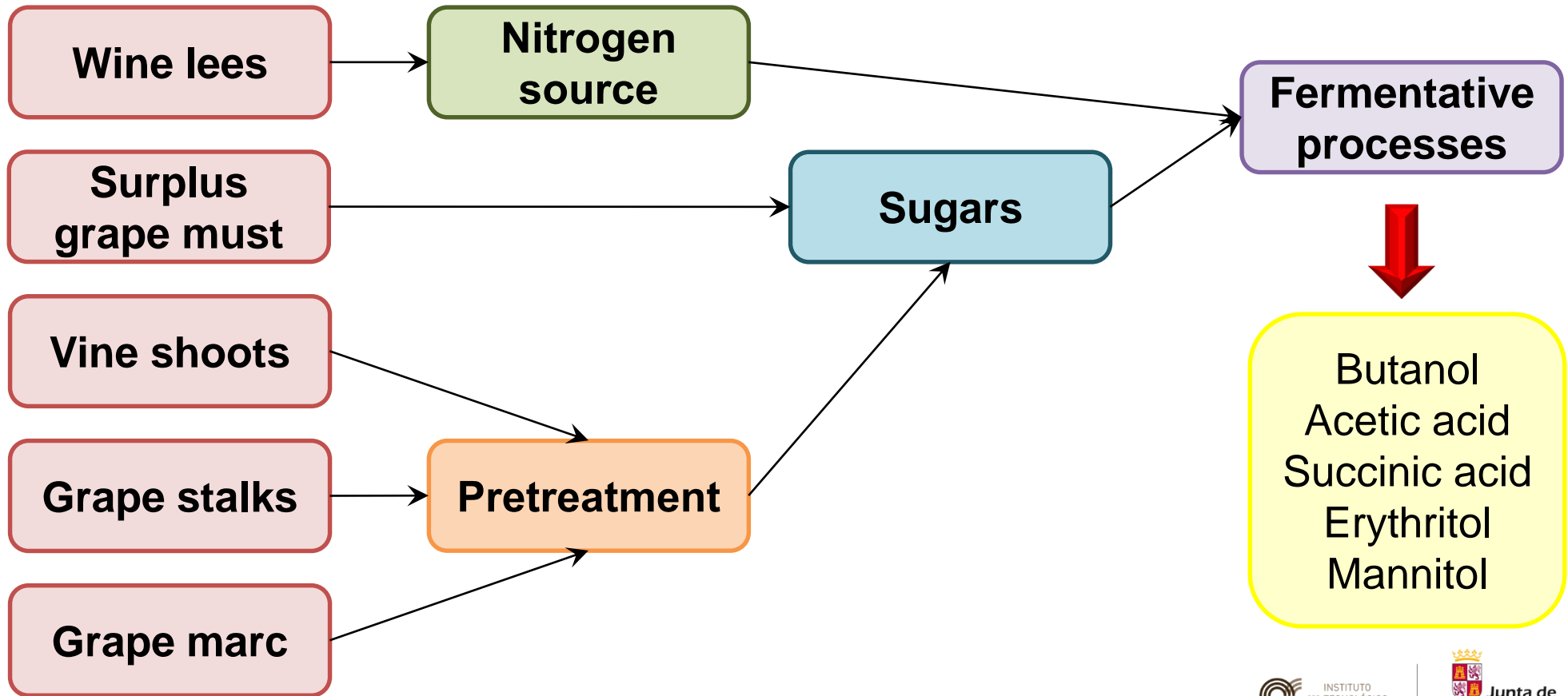
	Grape must (red-claret-rosé-white)
Total sugars (g/L)	197-244
Glucose (g/L)	98-125
Fructose (g/L)	99-119
Protein (g/L)	2-4
Phenolic compounds (g/L)	0.2-0.8

	Wine lees (red-white)
Total sugars (g/L)	0-0.7
Protein (g/L)	43-76
Ethanol (g/L)	82-99
Phenolic compounds (g/L)	0.4-1.5

	Vine shoots	Grape marc, fresh (red-white)	Grape marc, exhausted (red)	Grape stalk
Carbohydrates (%)	49.3	22.6-39.8	18.2	35.5
Cellulose (%)	32.8	4.7-7.5	6.4	19
Hemicellulose (%)	11.3	5.0-8.1	7.6	8.9
Lignin (%)	21.3	33.4-45.8	48.6	24.7
Protein (%)	4.3	5.7-9.0	9.8	5.7
Lipids (%)	0.5	3.8-6.3	5.8	1.0
Ashes (%)	2.4	3.1-4.3	4.4	8.2
Moisture (%)	7.9	5.2-5.6	3.7	7.5
Phenolic compounds (mg/g)	13.3	20.6-21.6	20.0	18.1

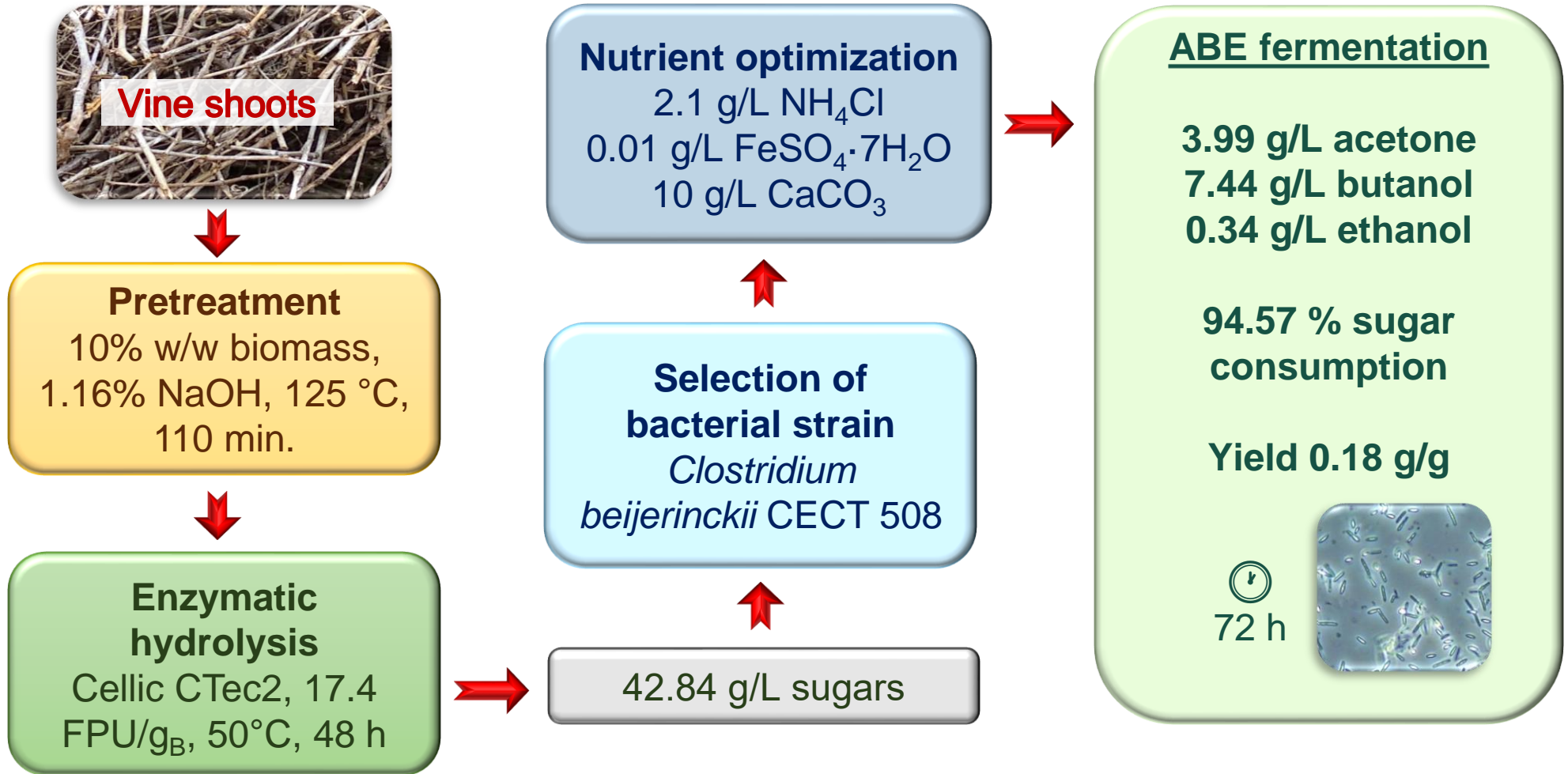


# Transformation route



# **Lignocellulosic biomass: Vine shoots**

# Butanol



# Lactic acid



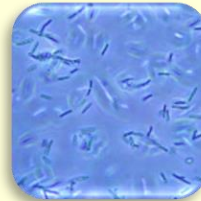
**Pretreatment**  
10% w/w biomass, 1.72% H<sub>2</sub>SO<sub>4</sub>, 134 °C, 17 min

**Enzymatic hydrolysis**  
Cellic CTec2, 17.4 FPU/g<sub>B</sub>, 50°C, 48 h

40.21 g/L sugars



**Thermotolerant strains. Fermentation under non-sterile conditions.**

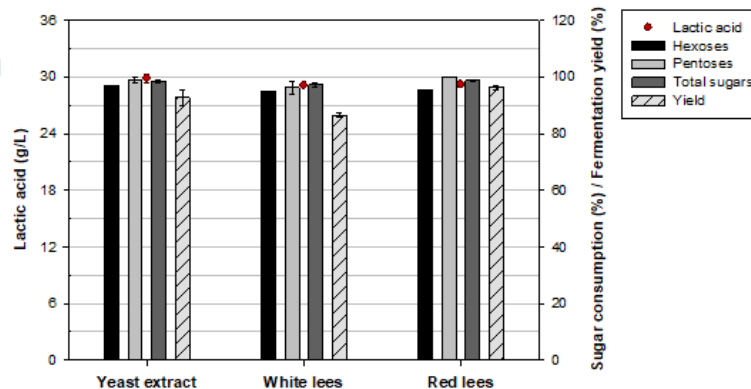


*Bacillus coagulans* DSM 2314



**Nitrogen source:**  
White lees  
Red lees

24 h



**Lactic fermentation**

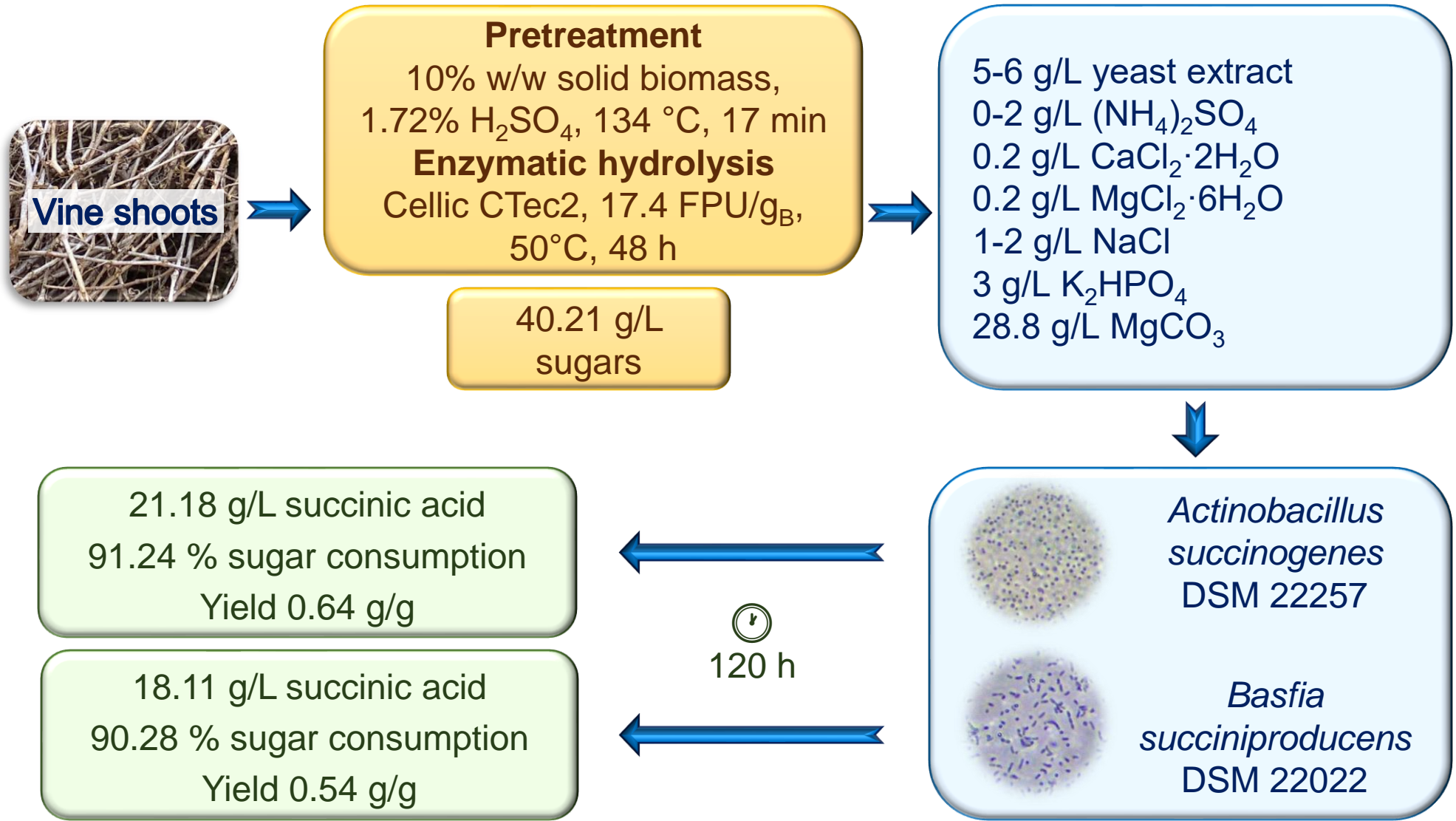
29.21 g/L lactic acid

98.74 % sugar consumption

Yield 0.96 g/g

Isomer L(+): 97.59%

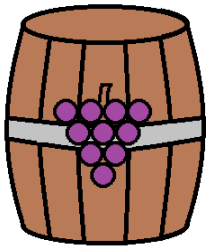
# Succinic acid



# Grape must surplus

# Succinic acid

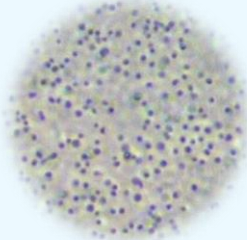
Red grape must



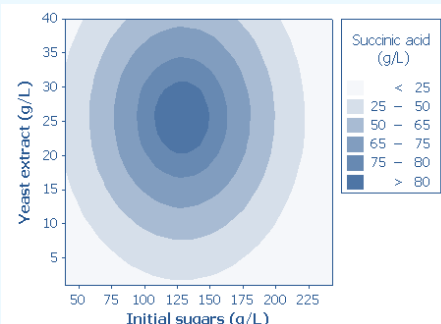
Dilution with water:  
145.7 g/L total sugars

Addition:  
24.9 g/L yeast extract  
116.5 g/L MgCO<sub>3</sub>





*A. succinogenes*  
DSM 22257

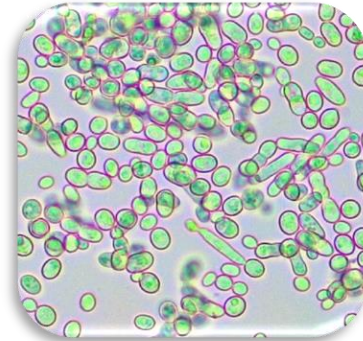
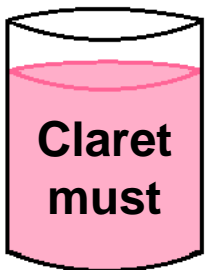




88.9 g/L succinic acid  
93.96 % sugar consumption  
Yield 0.66 g/g


  
96 h

# Erythritol



*Moniliella pollinis*  
MUCL 40570



  
 Addition:  
 6.7 g/L yeast extract  
  
 Aeration (>20%  
 dissolved O<sub>2</sub>)

93-96 g/L erythritol  
 99.5 % sugar consumption  
 Yield 0.36-0.38 g/g

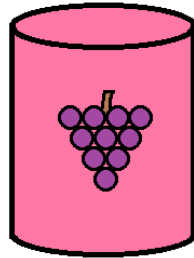


120-144 h

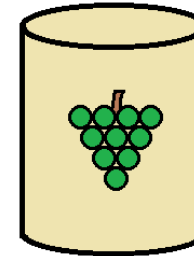


# Mannitol

Red must



White must



Dilution with water:  
155-175 g/L total sugars

Addition:  
0.8 g/L total nitrogen  
0.05-0.09 g/L  $\text{MnSO}_4 \cdot \text{H}_2\text{O}$

*Lactobacillus fermentum*      *Lactobacillus intermedius*      *Leuconostoc mesenteroides*

**Nitrogen source:**

Yeast extract      Red wine lees      White wine lees

68.9-79.8 g/L mannitol  
65-69 % sugar consumption  
Yield 0.888-0.895 mol/mol

⌚  
48 h

59.4-65.6 g/L mannitol  
56-59 % sugar consumption  
Yield 0.960-0.975 mol/mol

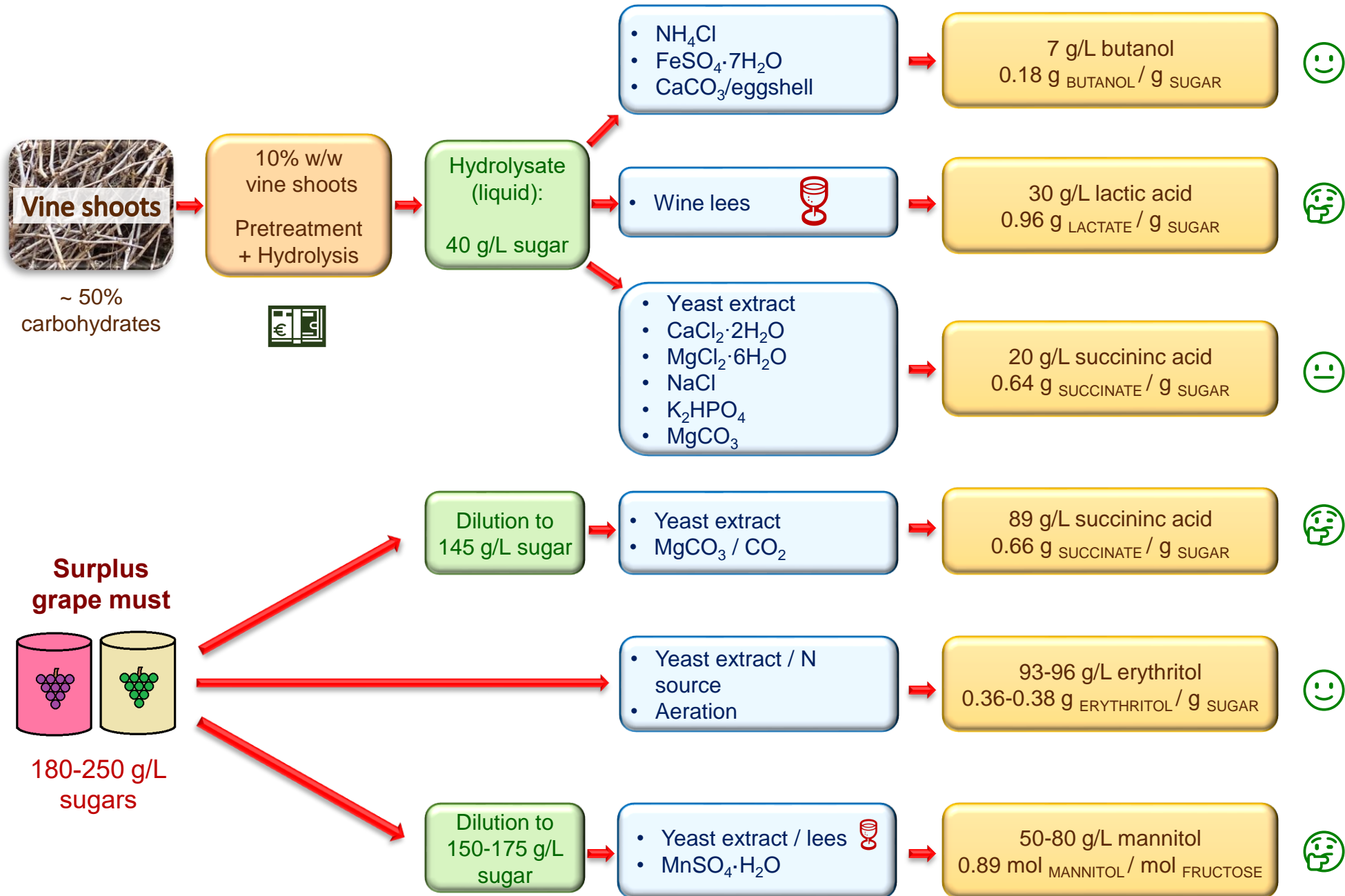
⌚  
144 h

51.2-57.8 g/L mannitol  
50-51 % sugar consumption  
Yield 0.976-1.009 mol/mol

⌚  
144 h

# Summary

# Summary



**Thank you very much for your attention!**

[www.biovino.es](http://www.biovino.es)