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g Up Valuable  
2026

# Compound Recovery from Distillery Vinasse

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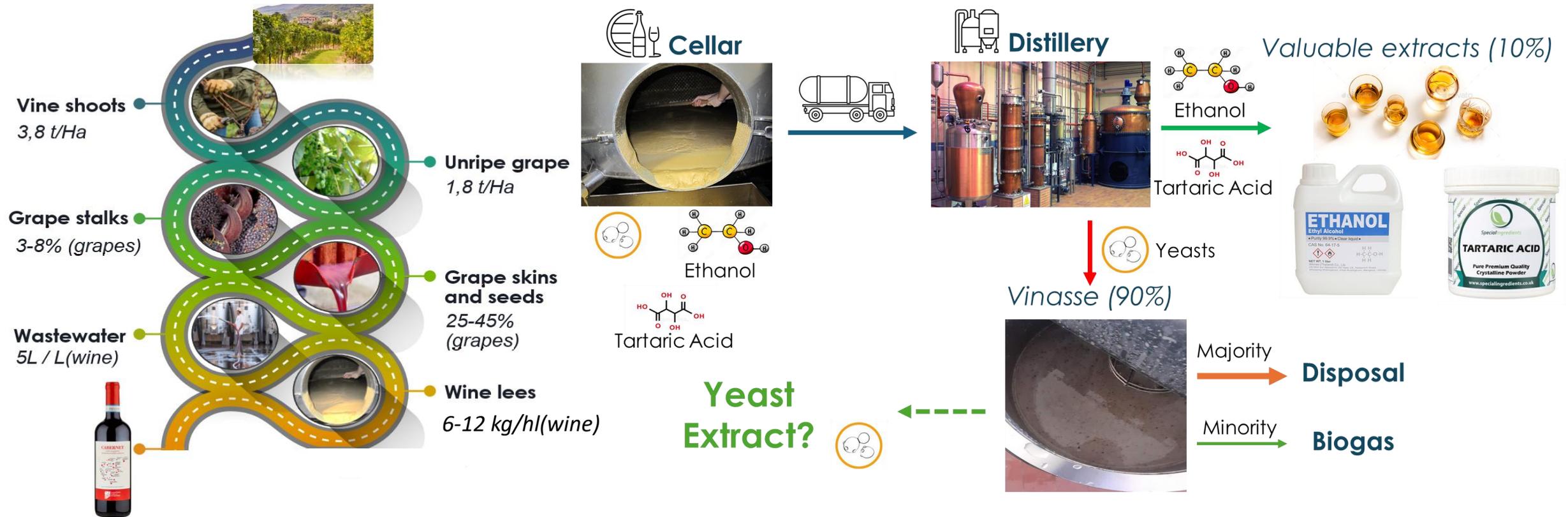
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per la Ricerca in Viticoltura ed  
Enologia



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# Recovery of valuable compounds from vinasse



Winemaking generates large by-product streams:

- ~50% of processed grapes become by-products
- Wine lees: 6–12 kg·hL<sup>-1</sup> of wine
- Mandatory distillation

Vinasse is not waste:

- It accounts for roughly 90% of the distilled mass
- Still rich in yeast biomass (mannoproteins, β-glucans, proteins)
- Usually discarded despite its high valorisation potential

# Laboratory procedures and the “valley of death”



LWT  
Volume 136, Part 1, January 2021, 110274



LWT  
Volume 152, December 2021, 112273



A novel approach for the valorization of wine lees as a source of compounds able to modify wine properties

Alberto De Iseppi<sup>a</sup>, Matteo Marangon<sup>a,\*,</sup> Simone<sup>b</sup>, Benoit Divol<sup>b</sup>

JOURNAL OF  
**AGRICULTURAL AND  
FOOD CHEMISTRY**

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Article

Chemical and Electrochemical Assessment of Wine Lees Extracts Tested as Novel Antioxidant Additives in Model Wine

A. De Iseppi, A. Curioni, M. Marangon,<sup>\*</sup> D. Invincibile, D. Slaghenaufi, and M. Ugliano

Red and white wine lees as a novel source of emulsifiers and foaming agents

Amolino<sup>a</sup>, Antonella Crapisi<sup>a</sup>, Andrea Curioni<sup>a, b</sup>



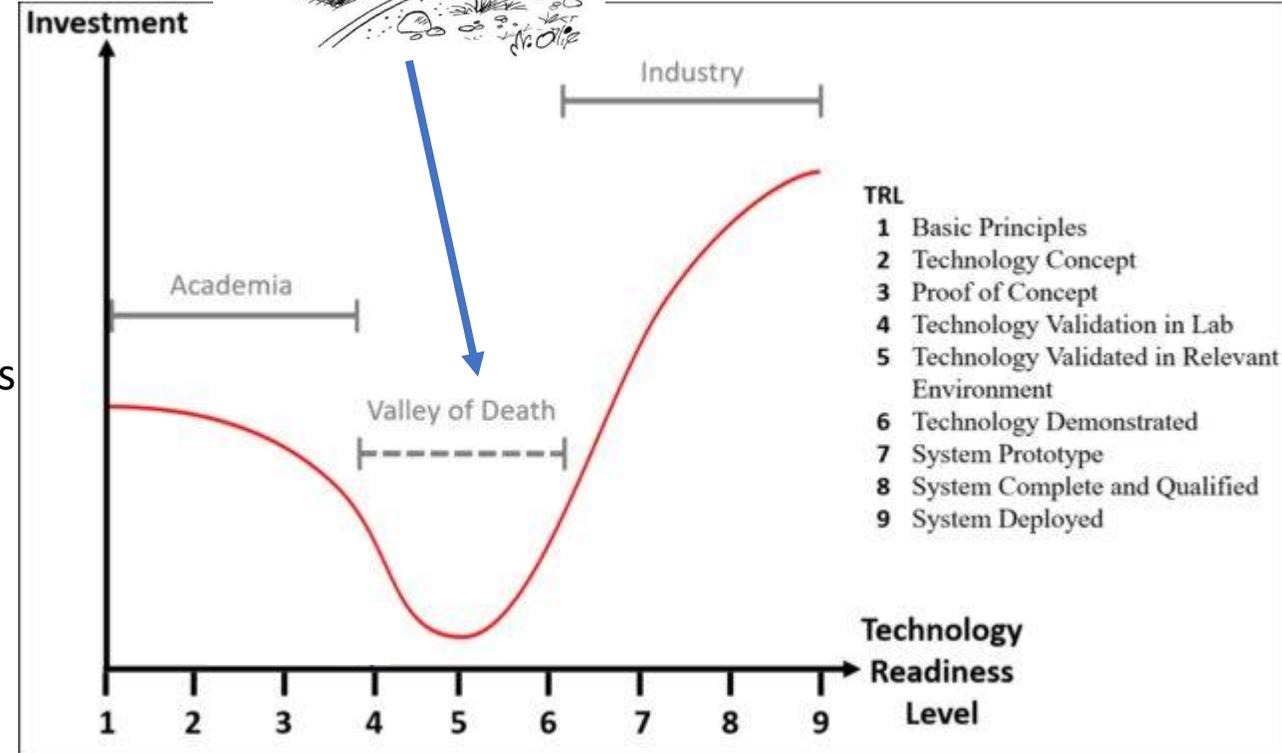
Development of a laboratory procedure to extract valuable compounds from vinasse

- High extraction yields reported for wine lees and vinasse

- Methods based on **autoclave conditions**

**Why this is a problem**

- 121 °C = high pressure
- Expensive, batch-based equipment
- Difficult to integrate into existing distilleries
- Subject to strict regulation (PED EU Dir.)



# Aims of the study

The overall aim was to prepare for scale-up of the protocol, generating the data required to design the final plant.

- ✓ *Generate pre-engineering data ( $\rho$ ,  $c_p$ ,  $\mu$ )*
- ✓ *Quantify how different fractions of interest behave under changing extraction conditions*
- ✓ *Based on this information, we designed the process and selected the most appropriate equipment.*

# Experimental design



## VINASSE solids (%)

- 10%
- 30%
- 50%



## TIME

- 20 min
- 40 min
- 60 min



## TEMPERATURE

- 104°C
- 108°C
- 112°C

**Lower than**  
autoclave  
↓  
Cheaper  
Equipment

**2 BENCHMARKS:**  $t_0$  (non treated); Autoclave (121°C, 20 min, 10% solids)

## Polysaccharides HPLC

- High MW
- Medium MW
- Low MW

## Proteins (BCA Assay)

## Physical properties

- Viscosity
- Density
- Specific heat



Response surface methodology (RSM)

## Plant layout

- Best conditions
- Apt equipment

# Optimization, for the different fractions

## High MW Polysaccharides (1100–180kDa)

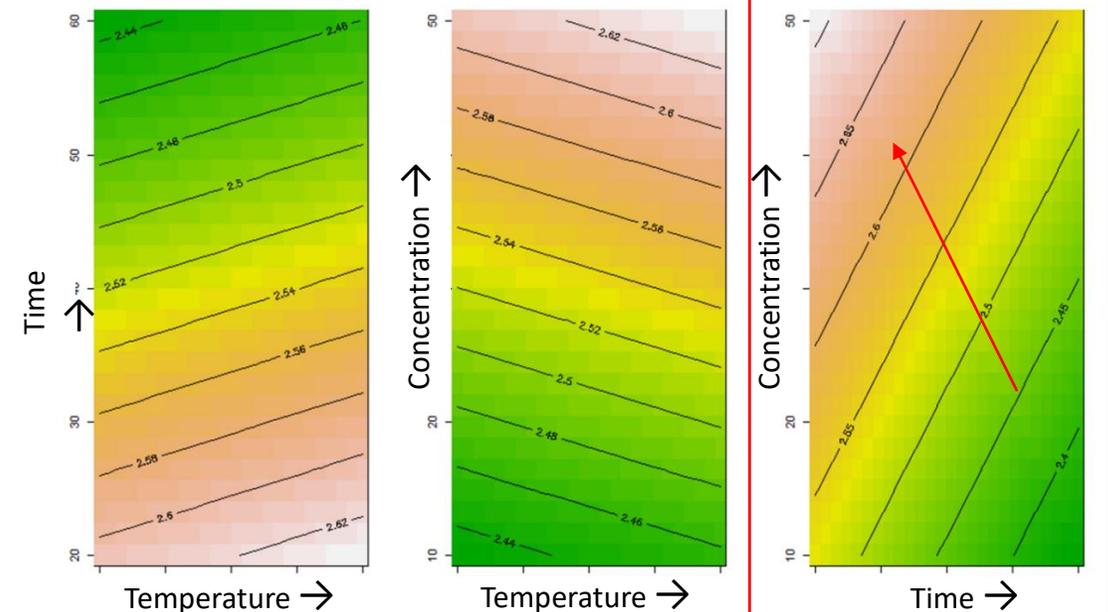
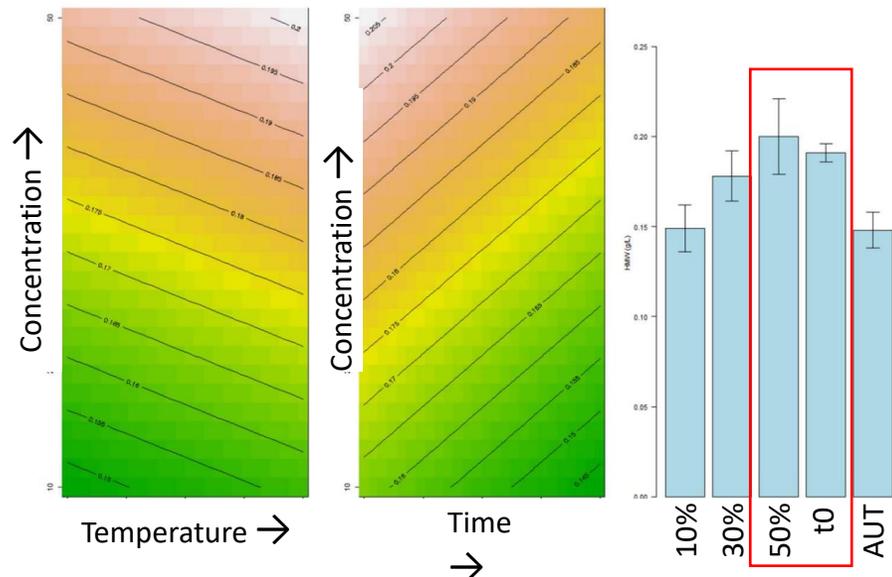
## Medium MW Polysaccharides (180–40 kDa)

Literature → Fractions rich in Mannoproteins with emulsifying, foaming, wine stabilizing properties

- t0 (non treated vinasse) → Best conditions
- Autoclave → Worst conditions
- High T, long t → HMW degradation
- **Recommended:** separation before heat treatment (= right after distillation)

- Treatments (high concentration) >>> t0
- Long time decrease extraction → degradation
- **Recommended:** 104°C, 20 min, 50% solids

Better than Autoclave



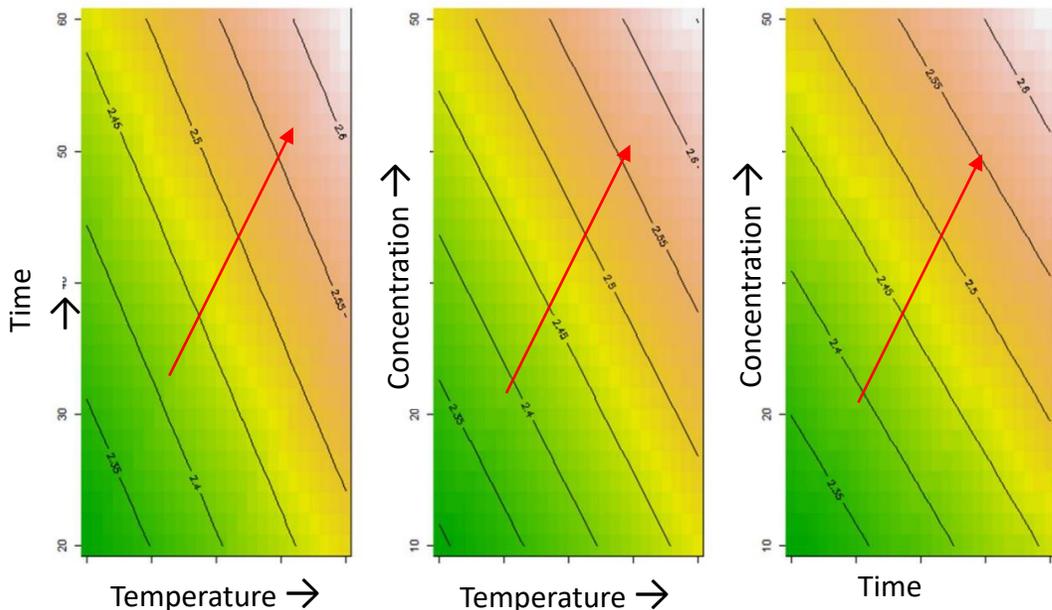
# Optimization, for the different fractions

## Low MW Polysaccharides (40-7.5 kDa)

Literature → Fraction rich in Mannoproteins with foaming properties and immunodulatory  $\beta$ -glucans

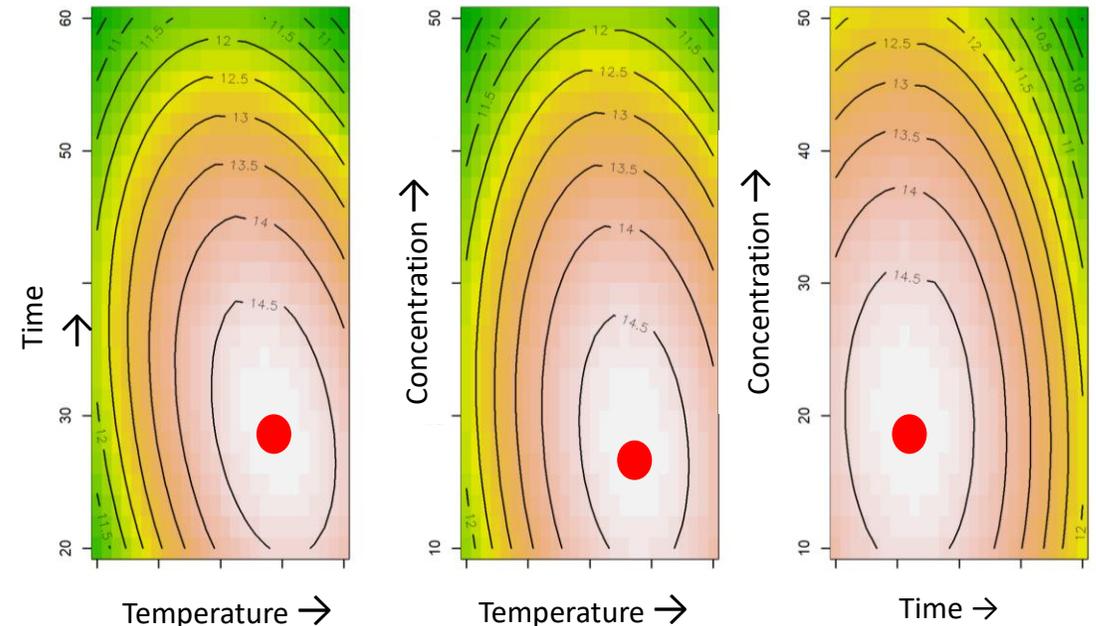
- High T, t, % → increase extraction
- **Recommended** 112°C, 60 min, 50% solids

Better than Autoclave



## Total proteins

- High extraction → higher purity of PS extracts
  - **Optimal:** 110°C, 30 min, 18% solids
- Better than Autoclave
- More severe conditions: Denaturation



# Optimization, for the different fractions

Fraction	Max extraction	Conditions
High MW PS <i>1100–180 kDa</i>	0.21 g/L	t0 (before treatment)
Medium MW PS <i>180–40 kDa</i>	2.83 g/L	104°C, 20 min, 50 % solids
Low MW PS <i>40-7.5 kDa</i>	2.79 g/L	112°C, 60 min, 50 % solids
Oligosaccharides <i>&lt; 7.5 kDa</i>	19.35 g/L	108°C, 40 min, 30 % solids
Proteins <i>Total</i>	15.07 g/L	110°C, 30 min, 18 % solids



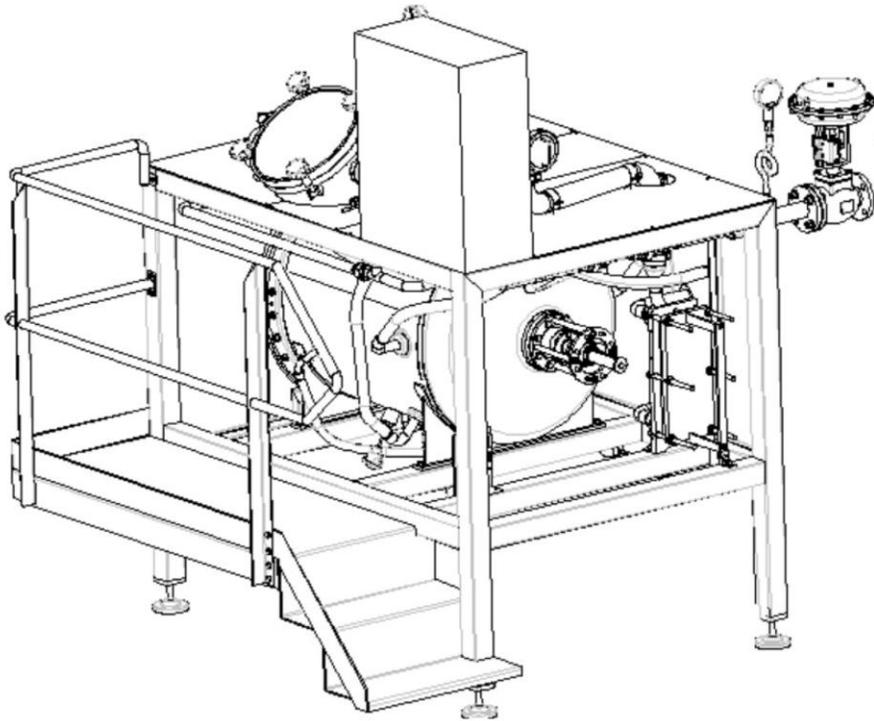
Main target

- Mannoproteins
- Soluble  $\beta$ -glucans

Secondary target  
(also extracted)

Viscosity	Specific heat	Density
7.17 → 89.80 mPa * s <sup>-1</sup> <i>(increase with solids)</i>	4.31 kJ/(kg×K)	1026.01 kg/m <sup>3</sup>

# Process design implications

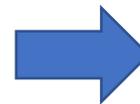


Cooker operating under pressure  
(consistent with 2014/68/UE – Pressure  
Equipment Directive PED)  
€ 140-150.000



Cooker operating at atmospheric  
pressure  
€ 45-70.000

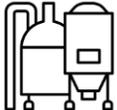
In addition, although viscosities were not excessively high, during the trials the vinasse showed a strong tendency to foul the cooker walls.



Introduction of a mechanical mixer to homogenise during the extraction

The next design decision will be between direct steam injection and external jacket heating, and it will be driven by additional thermophysical data.

# Proposed plant configuration



## Distillation



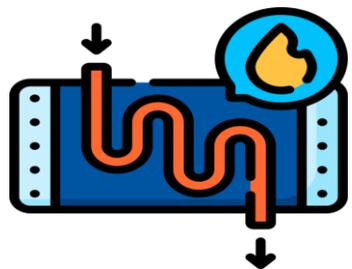
Vinasse (95°C)

## Other outputs

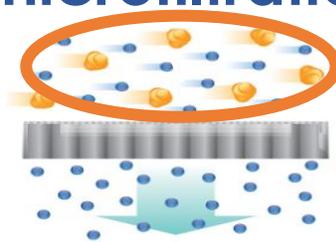
Heat: to produce  $\approx 1544$  kg/h of warm water (60°C)

Solid residues: Yeast cell debris  $\rightarrow$  rich in  $\beta$ -glucans

## Cooling (HEX)



## Cross-flow microfiltration



CONCENTRATION  
10  $\rightarrow$  50% solids

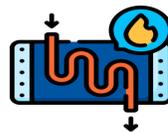
## Extraction (Cooker)



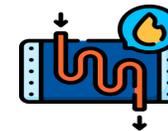
20 min, 104°C

60 min, 112°C

## Cooling (HEX)



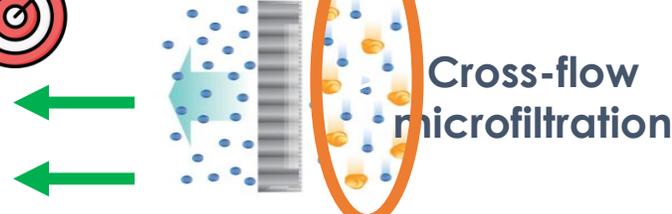
## Cooling (HEX)



Medium  
MW PS  
Proteins



Low MW PS  
Oligosaccharides



# Conclusions

Different target fractions require different, purpose-oriented extraction strategies

Autoclave-based extraction is not industrially optimal, mild conditions provide better performance

Vinasse was a good case study for by-product valorization plant scale-up

Simple, targeted, trials can provide support in moving from laboratory protocols to process design

A feasible plant-scale configuration is proposed

## **Future studies**

- Further optimization of the pilot plant
- Economical assessment

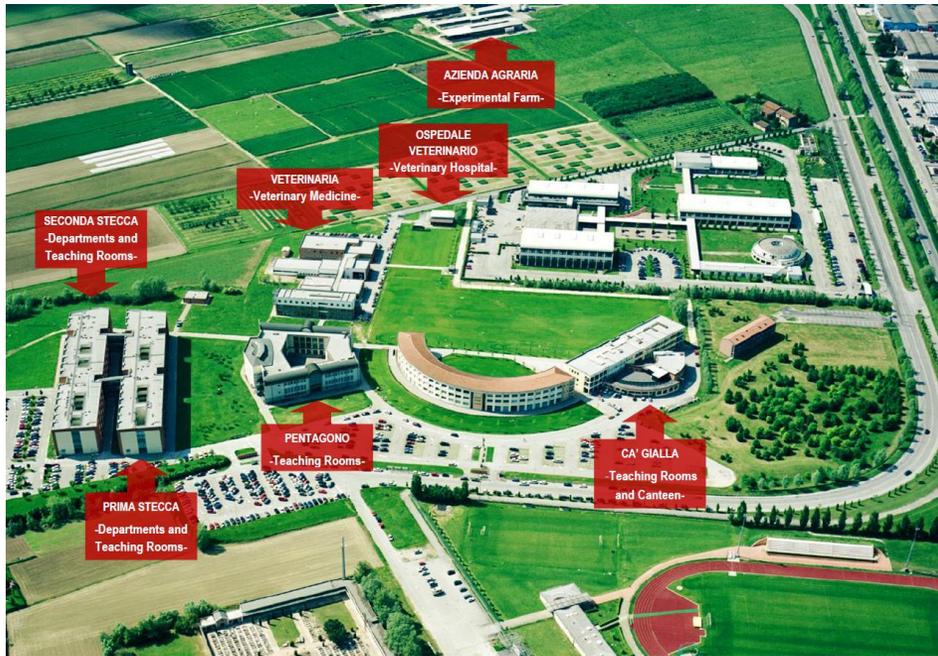
You can find more details here

Article

### Recovery of Valuable Compounds from Distillery Vinasse: Trials for Plant Scale-Up

Alberto De Iseppi <sup>1,2,\*</sup>, Matteo Marangon <sup>1,2</sup>, Andrea Curioni <sup>1,2</sup>, Anna Perbellini <sup>3</sup>, Alessandro Zanchin <sup>3</sup> and Lorenzo Guerrini <sup>2,3</sup>

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- <sup>3</sup> Department of Land, Environment, Agriculture & Forestry (TESAF), University of Padua, 35020 Legnaro, Italy; anna.perbellini@unipd.it (A.P.); alessandro.zanchin@unipd.it (A.Z.)
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# Thank you for your time! Any feedback is more than welcome!

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