Optimization of bioethanol production from a sugar-rich liquor and a functional animal feed ingredient obtained in the biorefinery scheme of grape stem

NEWFEED: Turn food industry by-products into secondary feedstuffs via circular-economy schemes

Jone Ibarruri – AZTI
- jibarruri@azti.es -

MEMBER OF
BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

CASE STUDY 1

Grape stem-based ingredients for dairy sheep and cattle

Current situation

- EU is the world-leading producer of wine (75 % in Italy, Spain and France)
- Annual production: 167 million hectoliters (1,5 kg of grape -1 L wine) > 750.000 Tn

1 Kg → **0.03-0.07 Kg**

10,000 tons

- Fibres
- Polyphenols
- Sugars

1st

Grape stem from wineries as a second-generation feedstuff to produce a new feed ingredient for ruminants (dairy sheep and cattle). AZTI / Spain.

Grape stems are the only by-product of winemaking that is managed as a waste

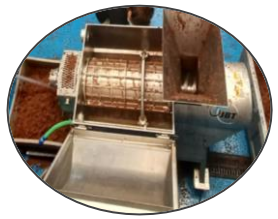
Objective

1. Development of a stem **washing process** to reduce sugars to **improve drying efficiency**

2. Asses the use of the **sugar rich liquor** to produce **ethanol**

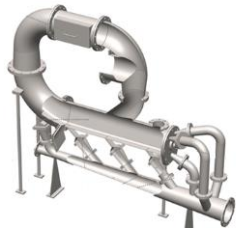
1 Kg

0.03-0.07 Kg



Washing

Washed grape stem



Flash dryer

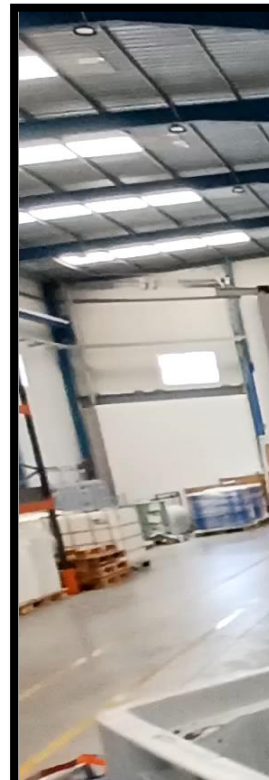
Grape stem ingredient

Feed formulation

Sugar rich liquor

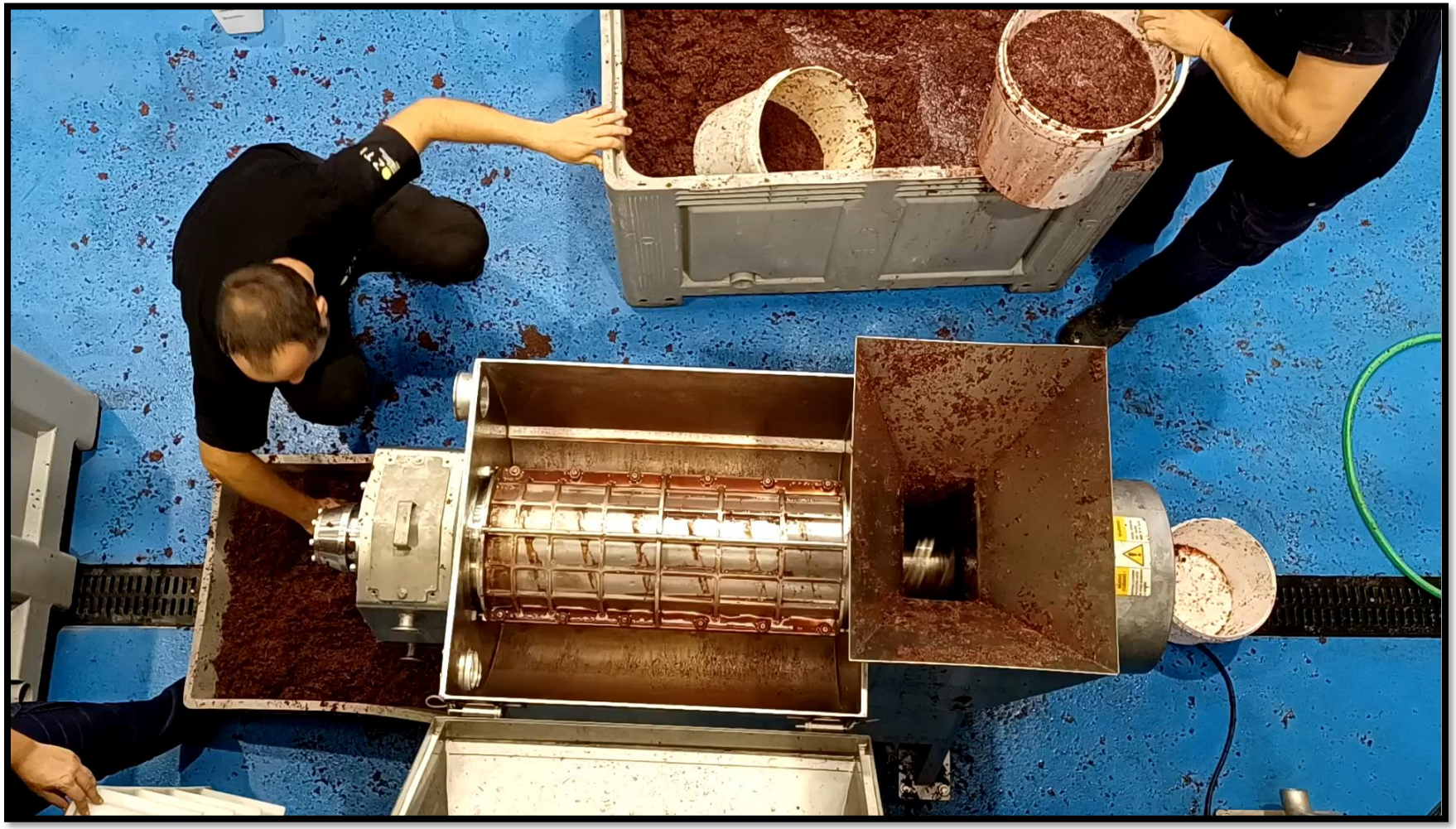
Feeding test

1. Development of a stem washing process to reduce sugars to improve drying efficiency

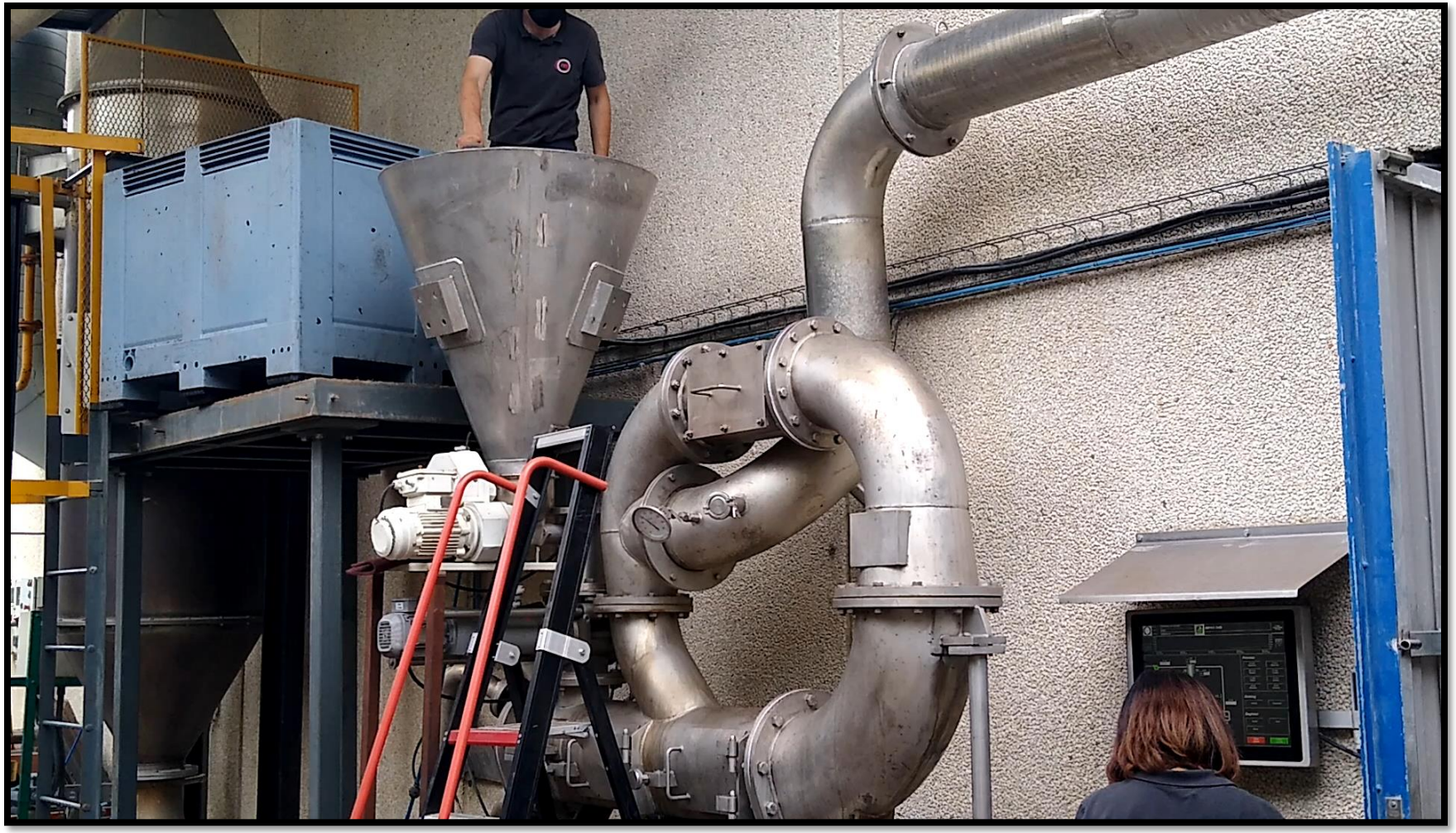


1. Development of a stem washing process to reduce sugars to improve drying efficiency

1. Development of a stem washing process to reduce sugars to improve drying efficiency



1. Development of a stem washing process to reduce sugars to improve drying efficiency



1. Development of a stem washing process to reduce sugars to improve drying efficiency

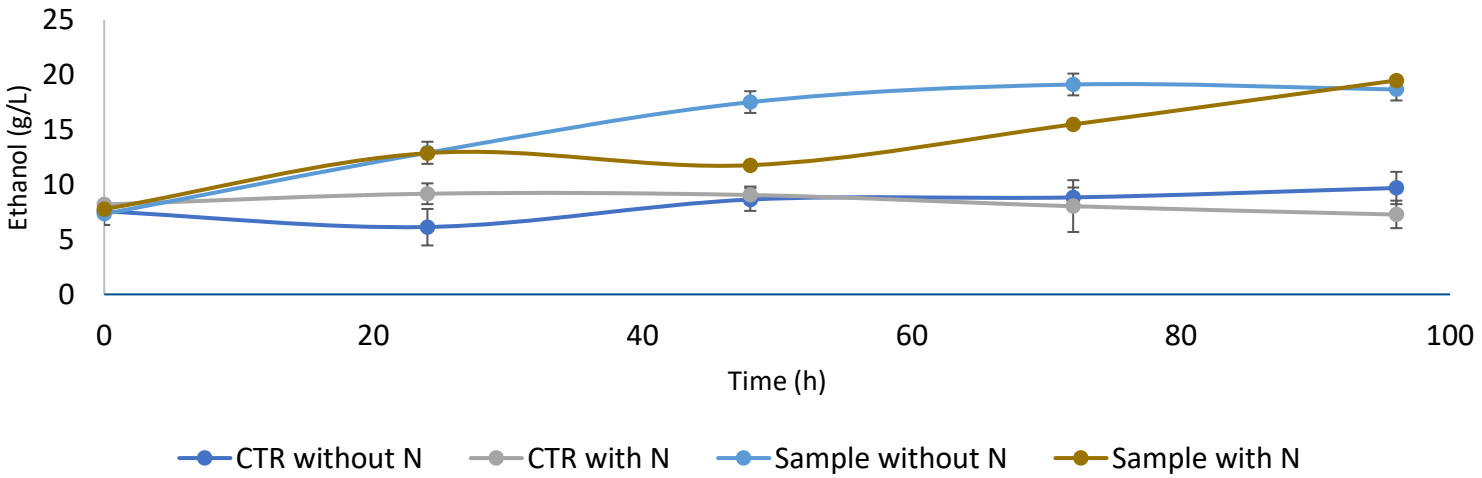
Parameter	Grape stem ingredient
Sugars (mg/g)	12.36
Polyphenols (mg/g)	30.55
Antioxidant activity (mg/g)	35.34
Protein (%)	5.66
Ash (%)	7.42
Acid detergent fibre (%)	50.95
Lignin (%)	22.36
Neutral detergent fibre (%)	53.18

2. Asses the use of the sugar rich liquor to produce ethanol

Initial tests

	Fructose (g/L)	Glucose (g/L)	Total sugars (g/L)	pH	Nitrogen (mg/L)
Sugar rich liquor	10.2	13.2	23.5	4.4	108

- Fermentation tests were performed (96 h, 28 °C, *Saccharomyces cerevisiae* BO213, Laffort)
- Initial sugars: 20 g/L (56 % glucosa - 44 % fructose). Extra nitrogen addition



- Starting samples have between 5 and 10 g/L ethanol
- Yield close to 100 %
- No difference with or without nitrogen addition
- Sugar consumption >90 %

2. Asses the use of the sugar rich liquor to produce ethanol

Degradation test

- **Objective:** Assess the degradation of compounds present in grape stems (10 days)
- A total of 150 kg of fresh stems were collected from 2 wineries
- They were stored in open bags (8 kg/per bag) in temperature-controlled chambers to simulate cellar conditions

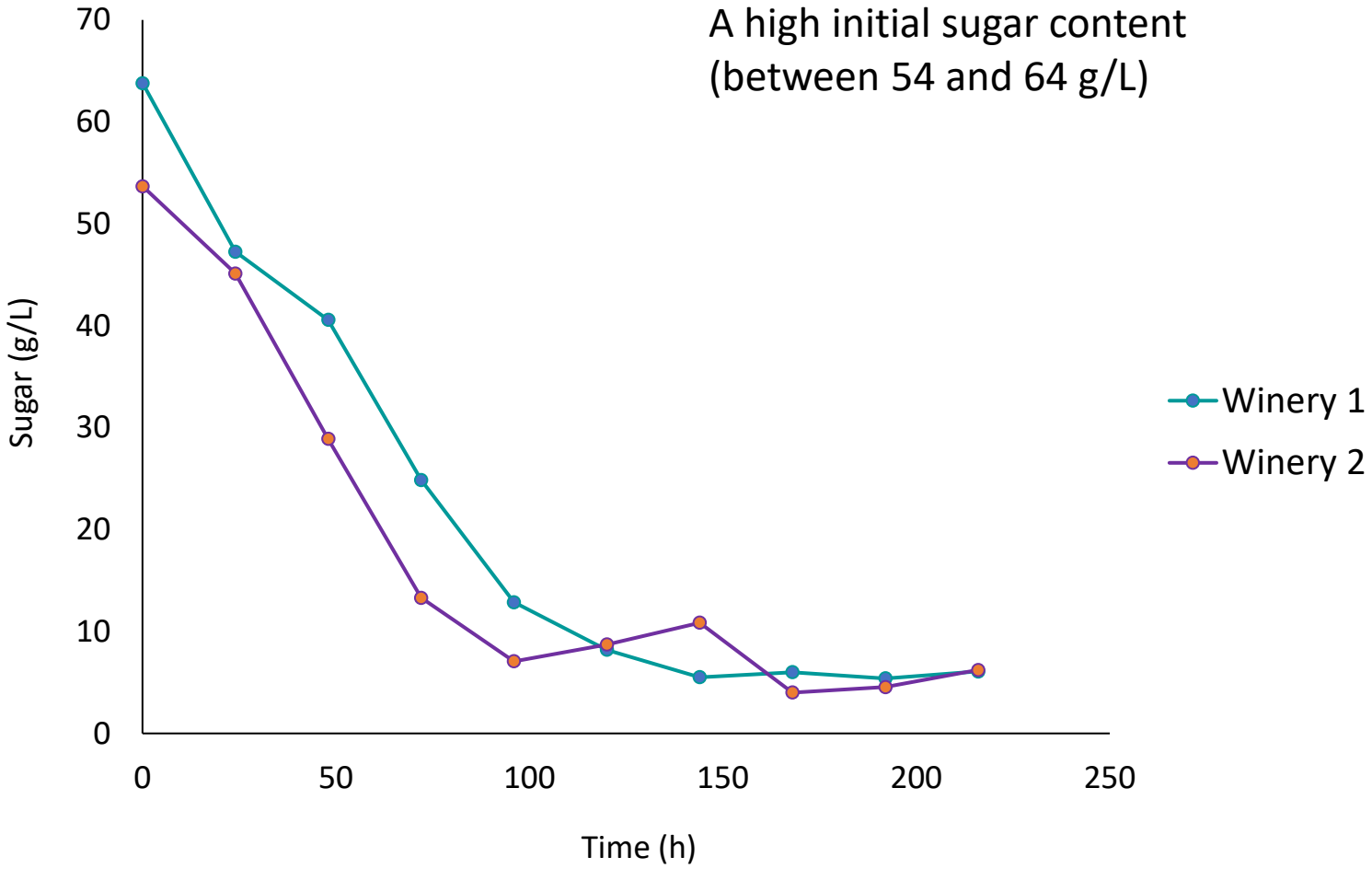
2. Asses the use of the sugar rich liquor to produce ethanol

Degradation test

- Grape stems were grinded and washed with water (1:1) to extract sugars with biotechnological potential
- This process was repeated every day (for 10 days)

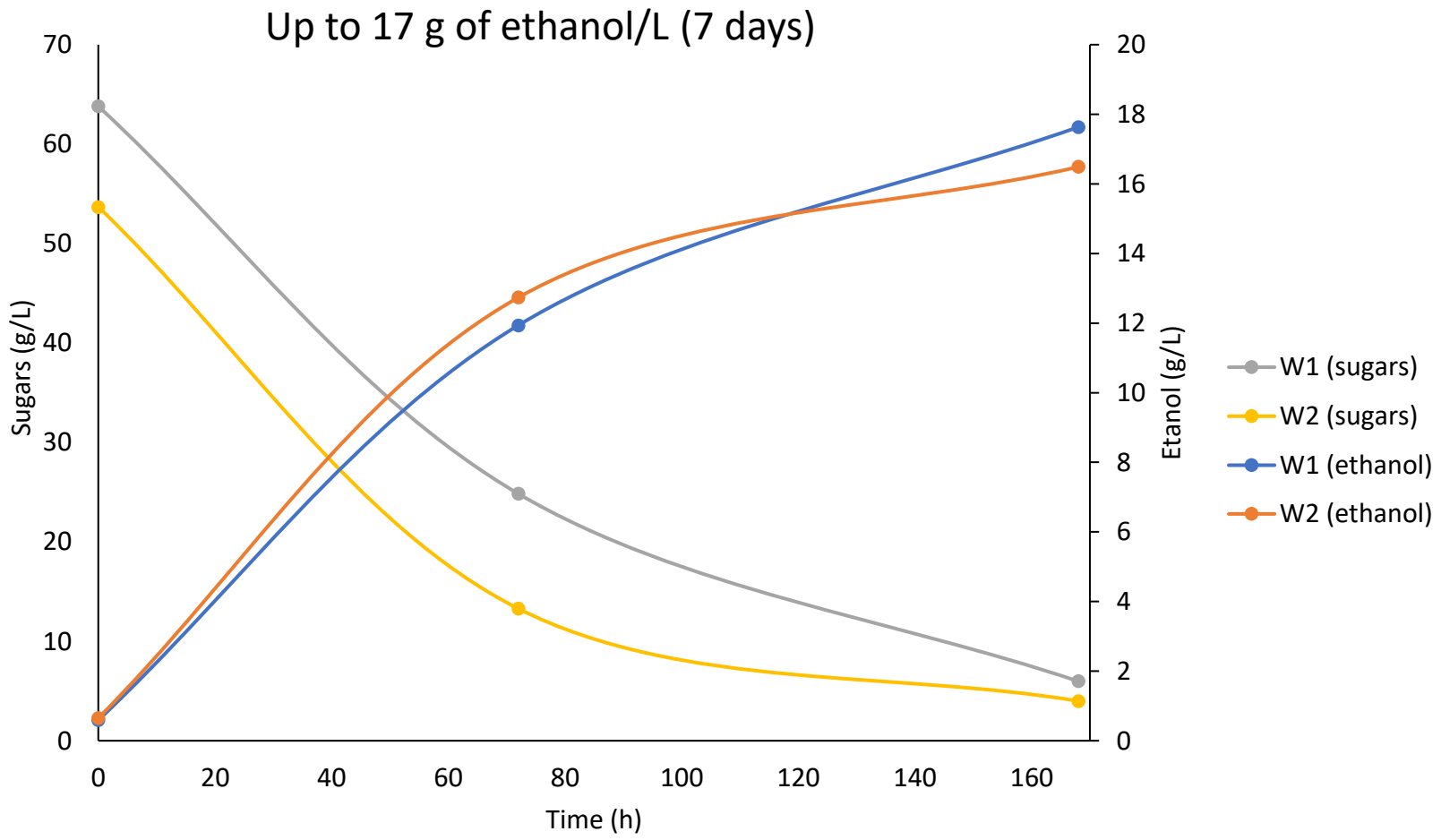
2. Asses the use of the sugar rich liquor to produce ethanol

Degradation test



2. Asses the use of the sugar rich liquor to produce ethanol

Degradation test

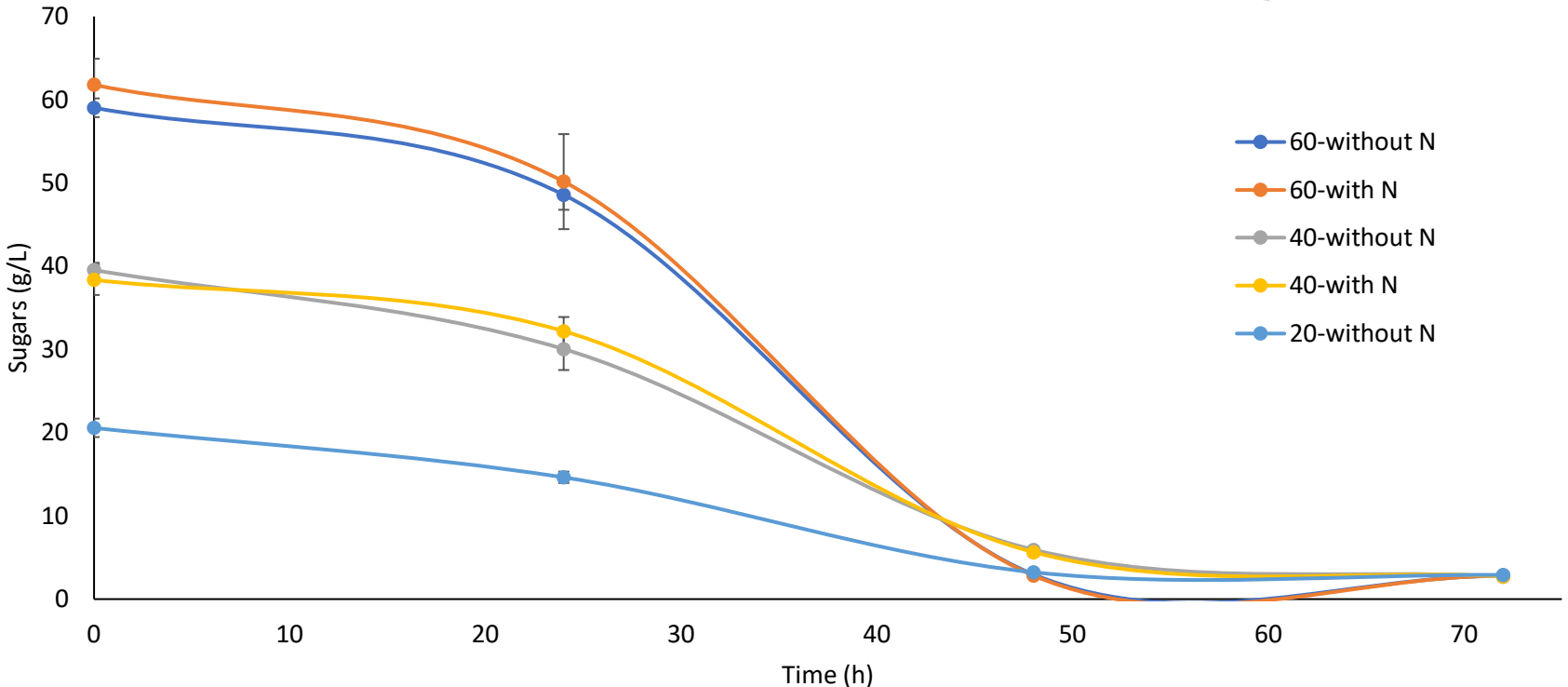


2. Asses the use of the sugar rich liquor to produce ethanol

Ethanol production potential in 3 possible stem collection scenarios

- Same day of generation
- 48 hours
- 72 hours

	Reducing sugars (g/L)	Ethanol (g/L)
Day 0	60.40	0.31
48 h	38.93	3.52
72 h	20.57	7.16

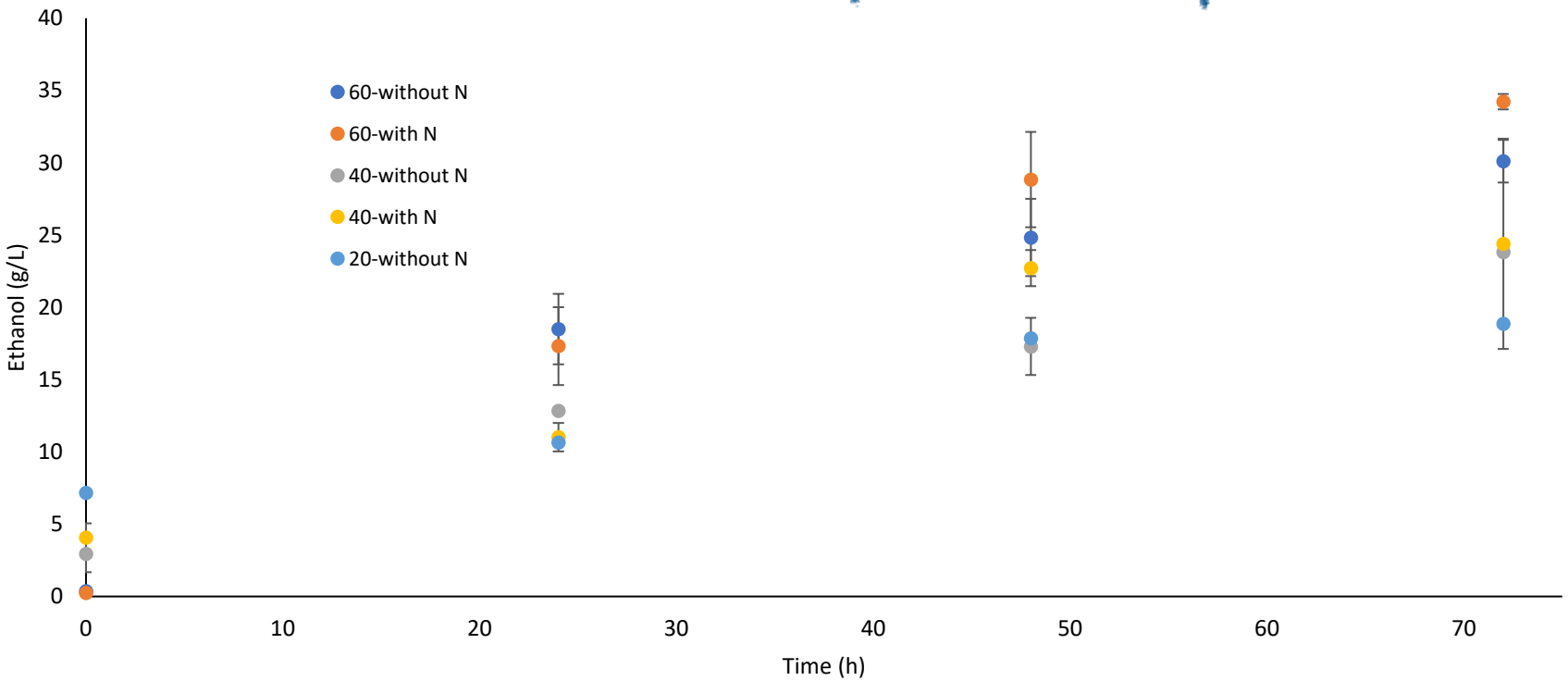


2. Asses the use of the sugar rich liquor to produce ethanol

Ethanol production potential in 3 possible stem collection scenarios

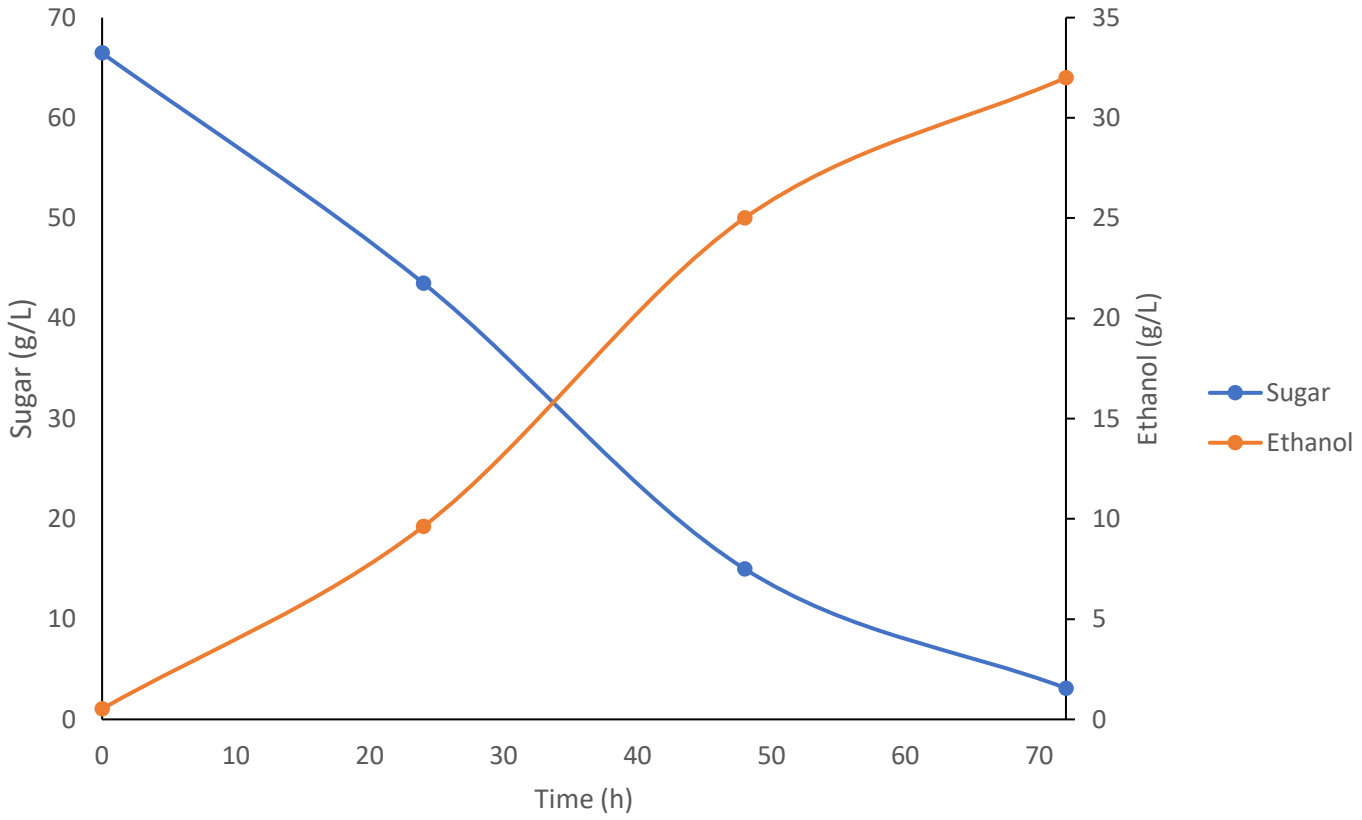
- Same day of generation
- 48 hours
- 72 hours

	Reducing sugars (g/L)	Ethanol (g/L)
Day 0	60.40	0.31
48 h	38.93	3.52
72 h	20.57	7.16



2. Asses the use of the sugar rich liquor to produce ethanol

Ethanol production scale-up in 5L reactor



2. Asses the use of the sugar rich liquor to produce ethanol

Legislative analysis

" Regulation (UE) 2019/787"

The ethyl alcohol and distillates used in the production of spirits shall be exclusively of agricultural origin

(a) has been obtained by **alcoholic fermentation**, followed by **distillation** exclusively of agricultural products

(b) it has **no perceptible flavour** other than that of the raw materials used in its production

(c) it has a minimum alcoholic strength by volume of **96.0 %**

(d) its **maximum residue levels** do not exceed those defined by law:

(i) ethyl acetate (ii) acetaldehyde (iii) higher alcohols (iv) methanol (v) Furfural

2. Asses the use of the sugar rich liquor to produce ethanol

Technical sizing

Scenario: 10,000 tons of grape stems/year in the Basque Country region for 3 or 4 months.

1st Option: 4 days of Storage in the cellar

	Units	Value
Ethanol	g ethanol / L	20.0
Liquor	Tn/year	7,000
Prize	€/tn	20

2nd Option: 7 days of Storage in the cellar

	Units	Value
Ethanol	g ethanol / L	17.0
Liquor	Tn /year	7,000
Prize	€/tn	17

Ethanol prize:
1000-2000 €/Tn

- Life Cycle Costing
- Life Cycle Assesment

Middle East Technical University

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

ONGOING

- Legal issues
- Analysis of the posible scenarios
- Market analysis
- Dissemination and Explotation plan

MEMBER OF
BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

CONCLUSIONS

- Grape stems are an available and cheap raw material with high potential to obtain a sugar rich liquor and an ingredient for animal feeding.
- The washing process educes the sugar content in order to improve drying efficiency.
- During the storage sugars were rapidly consumed (les tan 10 g/L after 48h) and up to 17 g of ethanol per litre were spontaneously produced, with lower yield than in controlled conditions.
- The optimization led to a final production of 25-30 g ethanol/L.
- Depending on the starting sugars, the final ethanol production will be higher or lower and this can help to better define the collection periodicity and the associated business model.

Thank you for your attention!

jibarruri@azti.es

Project Partnership

Demonstration under grant agreement n°2013

info@newfeed-prima.eu

https://newfeed-prima.eu/

David San Martin / AZTI: dsanmartin@azti.es

RHODES2024
11th International Conference on Sustainable Solid Waste Management
19-22 JUNE 2024
rhodes2024.uest.gr