
CHANIA2023

Biorefinery of grape stem to obtain a sugar-rich liquor for food applications and an ingredient for animal feed

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

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FEED FROM FOOD INDUSTRY BY-PRODUCTS

Jone Ibarruri – AZTI
- jibarruri@azti.es -

AZTI
MEMBER OF
BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

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FEED FROM FOOD INDUSTRY BY-PRODUCTS

Project Case Studies

Three value chains at the Mediterranean area will be validated to create new business opportunities based on a multi-actor approach in their conception, configuration and its sustainability assessment:

Project Partnership

AZTI · NEIKER · Riera Nadeu · UAGA · BAI GORRI · cesfac · Heliopolis University for Sustainable Development · SEKEM DEVELOPMENT FOUNDATION · iSiS · ΣΔΒΤ · ELGO-DIMITRA · UNIVERSITY OF WESTERN MACEDONIA · ORTA DOĞU TEKNİK ÜNİVERSİTESİ MIDDLE EAST TECHNICAL UNIVERSITY

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CASE STUDY 1

Grape stem-based ingredients for dairy sheep and cattle

AZTI NEIKER Riera Nadeu UAGA BAI GORRI cesfac

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Objective

Assess the use of **grape stem** from wineries as a **second-generation feedstuff** to produce a new feed **ingredient for ruminants (dairy sheep and cattle).**

- EU is the world-leading producer of wine.
- Average annual production 167 million hectoliters that suppose the 65 % of production.
- 75 % of EU production is produced in Italy, Spain and France.

3-5 %

Objective

Assess the use of **grape stem** from wineries as a **second-generation feedstuff** to produce a new feed **ingredient for ruminants (dairy sheep and cattle).**

3-5 %

- Fibres

cellulose, hemicellulose, lignin

- Polyphenols

foods MDPI

Review

Bioactive Compounds from Vine Shoots, Grape Stalks, and Wine Lees: Their Potential Use in Agro-Food Chains

Marica Troilo [1], Graziana Difonzo [1], Vito M. Paradiso [2], Carmine Summo [1] and Francesco Caponio [1,*]

antioxidants MDPI

Article

Grape Stem Extracts with Potential Anticancer and Antioxidant Properties

Javier Quero [1], Nerea Jiménez-Moreno [2], Irene Esparza [1], Carmen Ancín-Azpilicueta [2,*] and María Jesús Rodríguez [1]

Waste and Biomass Valorization
https://doi.org/10.1007/s12649-021-01533-8

SHORT COMMUNICATION

Grape Stalk-Based Extracts Controlling Fruit Pathogenic Fungi as a Waste Biomass Valorization Alternative in Winemaking

Marcela Kurina-Sanz [1]

Industrial Crops & Products 154 (2020) 112675

Contents lists available at ScienceDirect

Industrial Crops & Products

journal homepage: www.elsevier.com/locate/indcrop

ELSEVIER

Potential application of grape (*Vitis vinifera* L.) stem extracts in the cosmetic and pharmaceutical industries: Valorization of a by-product

Carla Leal[a], Irene Gouvinhas[a,*], Rafaela A. Santos[a], Eduardo Rosa[a,b], Amélia M. Silva[a,c], María José Saavedra[a,d], Ana I.R.N.A. Barros[a,e]

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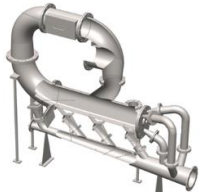


3-5 % → **Flash dryer** → **Grape stem ingredient** → **Feed formulation**

- Fibres

cellulose, hemicellulose, lignin

- Polyphenols

Feeding test

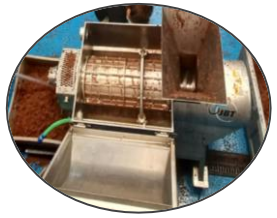
Objective

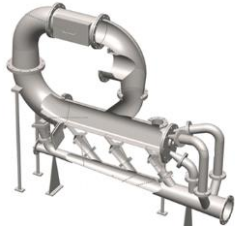
Evaluate a hydrolysis process to produce a sugar rich liquor from grape stem and improve dry digestibility

Optimize hydrolysis process to produce a sugar rich liquor from grape stem and improve dry digestibility

1 Kg

0.05 Kg → Washing → Washed grape stem → Hydrolysis → Flash dryer → Grape stem ingredient → Feed formulation





Washing → Sugar rich liquor

1-Nutritional characteristics

Dry matter, ash, crude protein, ether extract, NDF, ADF, LAD, NDICP and ADICP, sugars, polyphenols, antioxidant activity

2- In vitro digestibility value

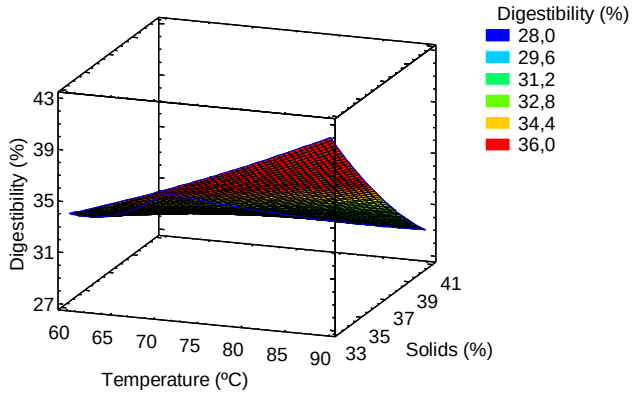
3- Ruminal fermentation kinetics

Rate and extent of gas production (mL/g DM)

Feed formulation → Feeding test

Lab scale

Optimization



Pilot scale

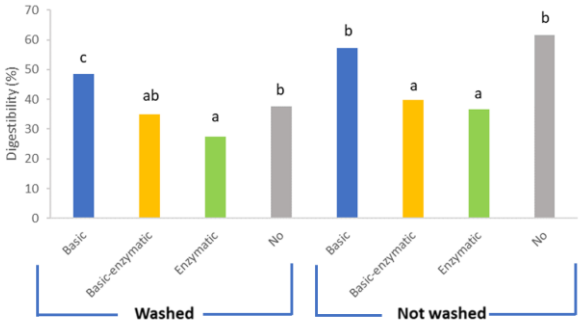
Lab scale

Optimization of the hydrolysis process

↓ Fibre fraction

↑ % of inclusion

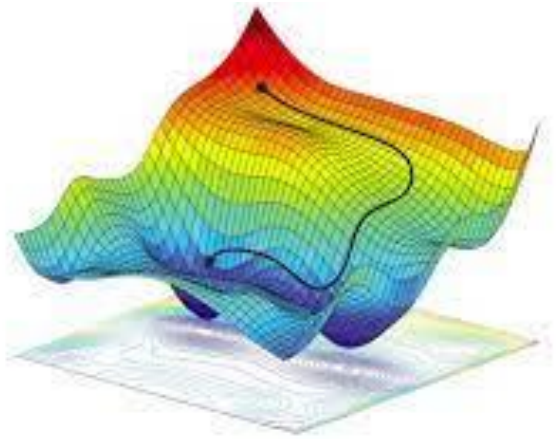
Wash	Hydrolysis	Conditions
Yes	1. NaOH	1% NaOH, ratio 1:1.25 w/w 90 ^{o}C 3 h 250 rpm
No	2. Cellulolytic Enzymes	Enzymes 2 % 55 ^{o}C 20h
	3. NaOH + Cellulolytic enzymes	Consecutive processes



- ✓ EH + **centrifugation**
  - Loss of nutrients
  - Decrease in polyphenols and sugars
  - Decrease digestibility
- ✓ AH although involving a centrifugation
  - Fibre degradation increases polyphenols and sugar availability when samples are washed
- ✓ **Digestibility**
  - AH improves digestibility when samples are washed

Optimization

Optimization of the hydrolysis process



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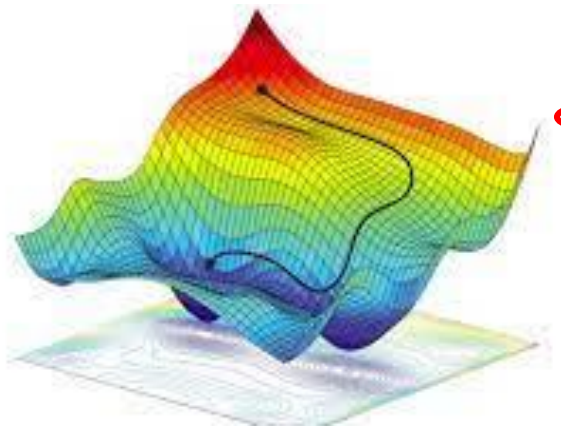
No	2. Cellulolytic Enzymes	Enzymes 2 % 55 ^{o}C 20h
	3. NaOH + Cellulolytic enzymes	Consecutive processes

Factors	Units	Low	Centre	High
A:Temperature	^{o}C	60	75	90
B:Time	h	1	2	3
C:Solids	%	33	36.5	40

Factor	Selected conditions
Temperature (°C)	90
Time (h)	2.3
Solids (%)	33.0

Optimization

Optimization of the hydrolysis process



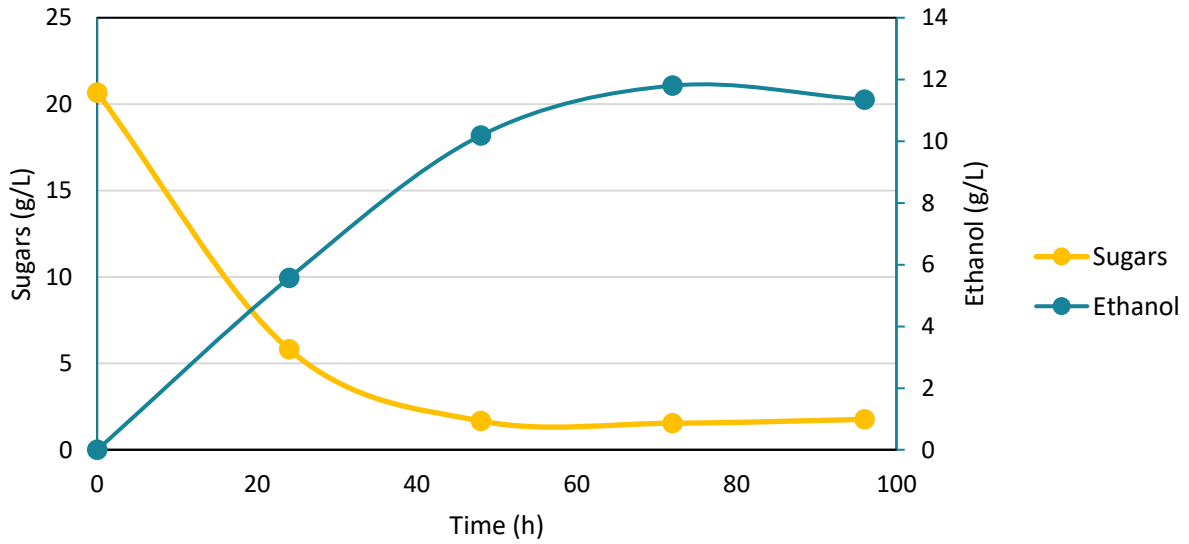
	Non-Hydrolysed sample	Hydrolysed sample
Sugars (mg/g)	199	204
Polyphenols (mg GAE/mg)	27.8	31.7
Antioxidant activity (mg TEAC/g)	35.0	37.4
Digestibility (%)	28.2	43
Ash (%)	10.2	13.7
Protein (%)	5.7	6.5
ADF (%)	36.0	47.6
Lignin (%)	21.3	34.8
NDF (%)	46.0	47.9
Total VFA (mmol/100mL)	4.9	5.4

Optimization

Bioethanol production

	Fructose (g/L)	Glucose (g/L)	Total sugars (g/L)
Liquor	10.2	13.2	23.5

✓ Almost all sugar are consumed (> 90 %)



Pilot scale

Test and validate the proposed value chain of grape stem (TRL 6-7)

New ingredient production

Feed efficiency trials

1. Milk yields
2. Milk quality
3. Curds sensory properties
4. Enteric methane emissions

Pilot scale *New ingredient production*

Collecting and Crushing → grape stems (69 % of moisture)




Pilot scale *New ingredient production*

Washing → Grape stems + Water (ratio 1:1)



Washed grape stem → 0.65 grape stems (79-80 % of moisture)

Liquor → 0.35 (bioethanol production)

Pilot scale *New ingredient production*

Hydrolysis → grape stems : water (0.6 % NaOH)




Hydrolysed grape stem after mechanical dewatering (72.8 % moisture)

Pilot scale *New ingredient production*

Washed grape stem (79-80 % of moisture)

Washed and hydrolysed grape stem (72.8 % moisture)





Dried grape stems (10 % of moisture) : 2 prototypes for animal feeding trials

Pilot scale

Feed efficiency trials

Grape stem-based ingredients **validated in two ruminant production systems**: dairy cattle and sheep.

	CTR	GS (hydrolysed and non-hydrolysed
Ingredients (%)		
Barley	5	19
Oats	53	24
Maize	10	15
ddgs	0	5
Rapeseed meal	21	16
Rapeseed oil	5	5
Molasses	3	3
Grape stems		**10**
VIT-MIN	3	3
Nutritive value		
UFL	1,01	0,99
CP (%)	15,8	16,1
Fat (%)	8,9	9,3
Starch (%)	32,2	32,6

CONCLUSIONS

- The washing process reduces the sugar content in order to improve the drying efficiency and solve the fermentation processes associated with the high sugar content in the raw material.
- The washing process reduces sugars in grape stems and, therefore, their nutritive value.
- AH improves in vitro digestibility of grape stems when samples are washed.
- The liquor obtained can be used as a source of sugars for bioethanol production.
- Grape stems can be formulated up to 10 % in dairy sheep's diets without impairing its nutritional value.

NEXT STEPS

- Animal feeding trials to validate prototypes
- Bioethanol production optimization
- Techno-economic feasibility study
- Life Cycle Assesment
- Legal and regulatory issues
- Dissemination and Exploitation plan

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PRIMA
PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

Thank you for your attention!

info@newfeed-prima.eu

David San Martin / AZTI: dsanmartin@azti.es

https://newfeed-prima.eu/

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