Production of biohydrogen from olive stones pretreated with organosolv

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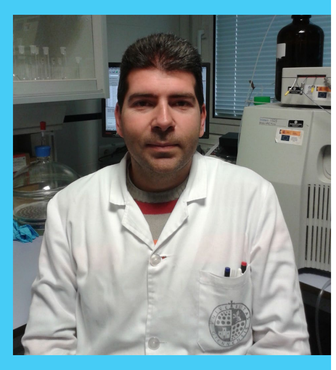


INTRODUCTION

The olive stones is the main solid residue of olive oil production, accounting for 10-12% of the olive weight. During the last season 2021-2022, the global olive industry produced about 2.8 million tons of olive oil from approximately ten million tons of olives. For this reason, the reuse of the associated waste contributes significantly to sustainability and care for the environment. An alternative for reuse of these wastes is to convert them through biological process into hydrogen (H_2) which is a clean energy source and an adaptable energy vector.
For the effective use of olive stones in fermentation processes, pretreatment of the biomass is necessary. Among these, chemical pretreatment by organosolvent is favorable for the removal of lignin from the biomass and disorganization of the cellular fiber,

OBJECTIVE

Assess the use of olive stones as a raw material for hydrogen production.

EXPERIMENTAL

BIOMASS → **PRE-TREATMENT** → **FERMENTATION** → **ANALYSIS**

Olive stones

Milling (0.1 cm)

Organosolv
50% EtOH
15% S/L
190 ºC/30 min

Pre-treated Olive stones

Batch: 50% headspace
Substrate: Olive stones 23.4 g/L
Macronutrient solution (pH 6.8)
Inoculum: *Clostridium butyricum* (5 g-TVS/L)
Incubation: 37 ºC, 130 rpm, 72h

Liquid chromatography (HPLC) with refractive index detector

Soluble metabolites:
Volatile organic acids
Inhibitors compounds
Sugars

Gas chromatography (GC) with TCD

H_2

RESULTS AND DISCUSSION

HYDROGEN PRODUCTION

Fit by modified Gompertz model

	Time for the start of H_2 production	H_2 production rate	H_2 production
In natura Olive Stones	28h	9.8 mL/L·h	54.4 mL/L
Pre-treated Olive Stones	50h	0.05 mL/L·h	96.4 mL/L

In Natura Olive Stones:

- H_2 production started earlier (28h)

→ >available soluble sugars (300 mg/L)

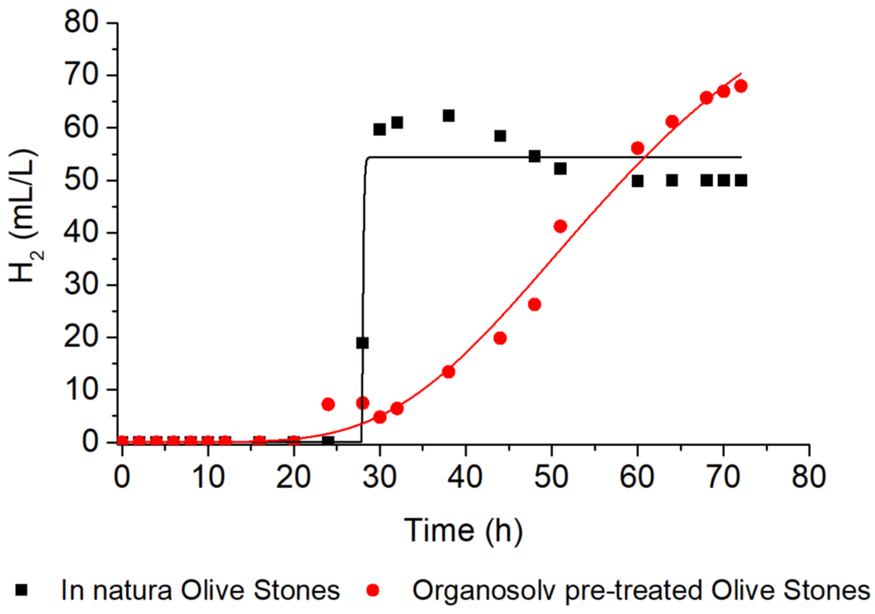
- > H_2 production rate (9.8 mL/L.h)

→ + H_2 in less time

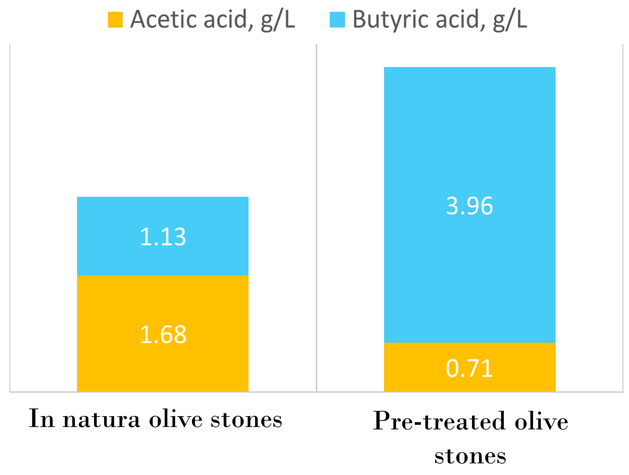
Pre-treated Olive Stones:

- > H_2 production (96.4 mL/L)

→ Increased biomass surface area for hydrolysis and bacterial fermentation



ORGANIC ACIDS PRODUCTION



Pre-treated Olive Stones:

- + 71% Buryric acid → > fermentative activity
- Typical fermentation of *Clostridium* species:

Acetic-butyric fermentation

$C_6H_{12}O_6 + 2H_20 \rightarrow 2CH_3COOH + 4H_2 + 2\ CO_2$

$C_6H_{12}O_6 + 2H_20 \rightarrow 2CH_3CH_2CH_2COOH + 4H_2 + 2\ CO_2$

CONCLUSIONS

The application of pre-treatment to biomass contributed to increase the H_2 production by 1.7 times due to greater accessibility to cell fibre for hydrolytic/fermentative bacteria. Another value-added product was obtained: butyric acid, which has numerous industrial applications, from the food to pharmaceutical industries.
The H_2 biological production from olive stones is a sustainable option for waste treatment with concomitant energy production.

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