UV/H_2O_2 PRETREATMENT FOR THE ENHANCEMENT OF METHANE FROM OLIVE TREE PRUNING BIOMASS

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Introduction

Lignocellulosic biomass including olive tree pruning (OTP) could be used as feedstock for anaerobic digestion (AD). Although being abundant, especially in Mediterranean countries, like Greece, the main obstacles of their use are the low yields attained, due to the recalcitrant nature of their lignocellulosic content. The application of a pretreatment process prior to AD could improve the hydrolysis and the total methane yield. Different methods have been employed for the pretreatment of lignocellulosics and among them, alkaline hydrogen peroxide (H_2O_2) pretreatment, is a very promising one (Alexandropoulou et al., 2023). The mechanism of H_2O_2 pretreatment appears to involve the production of highly reactive oxygen species and subsequent oxidative depolymerization of lignin in the lignocellulosic biomass. In a UV/H2O2 system, ultraviolet radiation enhances the in situ production of % OH radicals through photochemical reactions over a very short period of time (Zhang et al., 2017) and thus it could be considered as an efficient pretreatment method in removing lignin and hemicellulose from lignocellulosic feedstocks, promoting their utilization for subsequent bioprocesses (Yang et al., 2018).

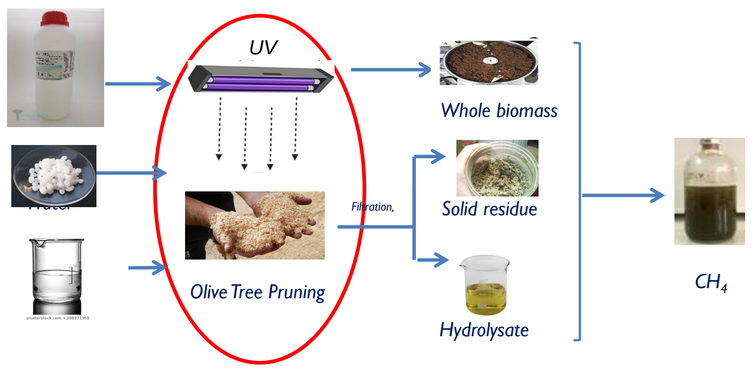
Objective

To investigate the effect of H_2O_2 in combination with ultraviolet (UV) radiation (UV/H_2O_2) at ambient temperature as pretreatment method for enhancing methane production from OTP. Three different concentrations of H_2O_2 (0, 1 and 3 % w/w) alone or in combination with UV radiation, at different retention times (8, 14 and 20 h) were tested. In addition, the combination of UV/H_2O_2 with alkali was compared with the typical alkaline pretreatment in terms of fractionation of lignocellulosics and methane generation.

Characterization

OTP dried, milled and sieved to a powder of 0.7 mm.

Characteristic	Value
TS ,(%)	92.03 ± 0.01
VS, (%TS)	91.91 ± 0.25
Cellulose, (%TS)	24.05 ± 0.47
Hemicellulose, (%TS)	15.88 ± 1.65
Lignin, (%TS)	41.28 ± 0.12
Extractives, (%TS)	16.93 ± 0.26



Mass ratio of solid(g) to liquid(mL) was 5:100 (organic load 5% w/v)

pretreatments

	Concentration (%)	Time (h)
UV/H_2O_2	0, 1,3	8, 14, 20
H_2O_2	1, 3	20
UV		20
H_2O		20
UV/NaOH/H_2O_2	1	20
NaOH	1	20

BMP tests

Tests: *were performed either at the whole slurry or at the separated fractions, obtained after pretreatment, based on Antonopoulou et al. (2020).*
Inoculum: *20 % v/v of anaerobic sludge from wastewater treatment plant*
Solid fractions *obtained after pretreatment at a final loading of 2g VS / L*
Liquid fractions *at a final chemical oxygen demand (COD) concentration of 2 g/L.*
Whole slurry *, solid loading of 5% w/v*

Results

Pretreatment

Analysis of lignocellulosic fraction

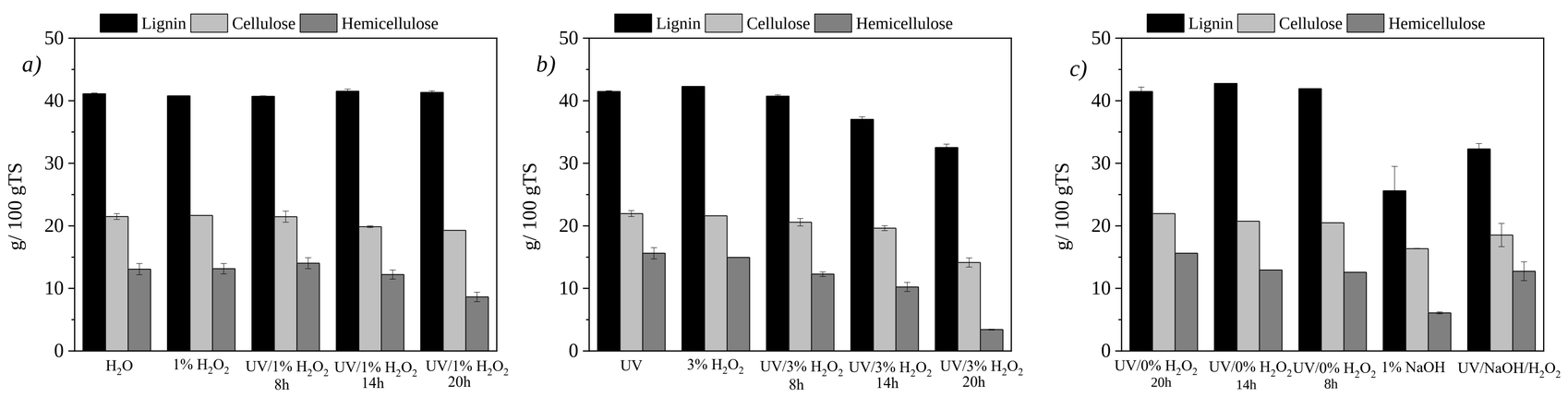


Figure 1: *The effect of different pretreatments on the fractionation of biomass in terms of lignin, cellulose and hemicellulose*

- ✓ *It is obvious that a slight lignin reduction occurred in the case of pretreatment with UV / 3% H_2O_2 for 14 h*
- ✓ *The reduction was more intense at UV / 3% H_2O_2 for 20 h or under the combination of UV/ NaOH / H_2O_2 for 20 h*
- ✓ *The highest lignin reduction was observed for alkaline (NaOH) pretreatment (37.96%).*

Methane production

Whole slurry

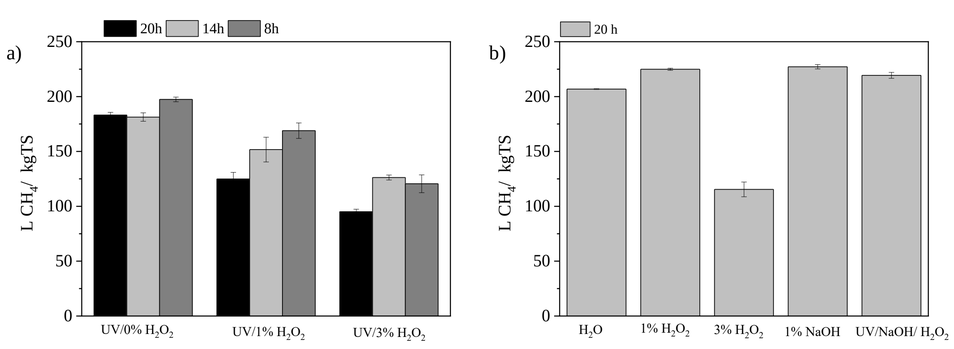


Figure 2: *The effect of different pretreatments on the BMP of the whole pretreatment slurry*

- ✓ *In the case of the UV/H_2O_2, the BMP decreased with the increase of the concentration and the retention time.*
- ✓ *Alkaline pretreatment alone, or in combination with the UV/H_2O_2 led to the higher methane potential.*

Separated fractions

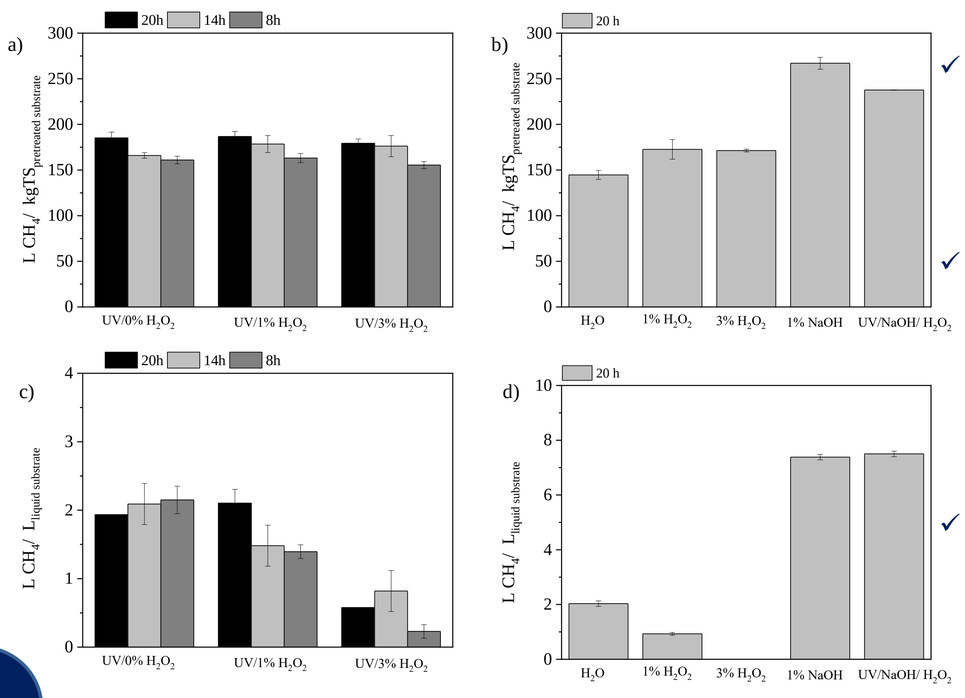


Figure 3: *The effect of different pretreatments on the BMP of the solid (a, b) and the liquid (c, d) fraction*

- ✓ *Like the anaerobic digestion of the whole slurry, alkaline pretreatment alone, or in combination with the UV/H_2O_2 led to the higher BMPs.*
- ✓ *For the solid fraction, in the case of the UV/H_2O_2, the BMP was influenced by the increase of the concentration and the retention time, but at lower degree than the whole pretreatment slurry.*
- ✓ *For the liquid fraction, in the case of the UV/H_2O_2, concentration of 3%, led to the lower BMP.*

Conclusions

- ✓ The experimental results obtained showed that alkaline pretreatment alone, or in combination with the UV/H_2O_2 led to the higher BMPs. This can be attributed to the lignin reduction during pretreatment.
- ✓ UV/H_2O_2 caused a decrease in the BMP.
- ✓ The higher the concentration of H_2O_2 and the retention time, the lower the BMP.

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