# Anaerobic phenol degradation via adsorption on conductive materials based on walnut shells

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## Introduction

Phenol is a toxic, intermediate chemical and common by-product in many industrial applications (Tian et al., 2020). During the last decades increasing attention has been paid to discovering alternative ways of removing phenols, establishing a wide range of different processes. Compared with other treatment technologies, anaerobic digestion (AD) is of considerable interest for its numerous advantages, such as lower energy consumption, lower biomass yield, and its ability to promote energy recovery in the form of methane. However, the high bio-toxicity of phenol to microbes and the low efficiency of hydrogen/formate interspecies electron transfer between syntrophic bacteria and methanogens limit the conversion of phenol to methane (He et al., 2019). Therefore, the addition of functional materials appears to provide a superior approach for enhancing anaerobic phenol degradation. Conductive materials, such as magnetite, carbon nanotubes and biochar have been used to enhance syntrophic methanogenesis by triggering direct interspecies electron transfer.

In this study, biochars, prepared by pyrolyzing walnut shells (WS) at 520 °C for 1 h under nitrogen atmosphere, as well as WS without any treatment were used on the AD of phenolic compounds, through biochemical methane potential (BMP) tests. Glucose at 2 g/L chemical oxygen demand (COD) supplemented with pure phenol or syringic acid at 0.5 g/L, was used as substrate, while WS or WS biochars (1 g/L) were added to promote the AD process.

## Characterization of WS and biochars from WS

WS and biochars WS were characterized in terms of their surface area and crystallinity using BET and X-Ray Diffraction (XRD) techniques, respectively (table 1 and figure 1).

**Table 1:** BET surface area of WS and biochars WS

| Sample | BET Surface Area ($m^2/g$) |
|---|---|
| WS raw | 0.6 |
| Biochar WS | 317.1 |

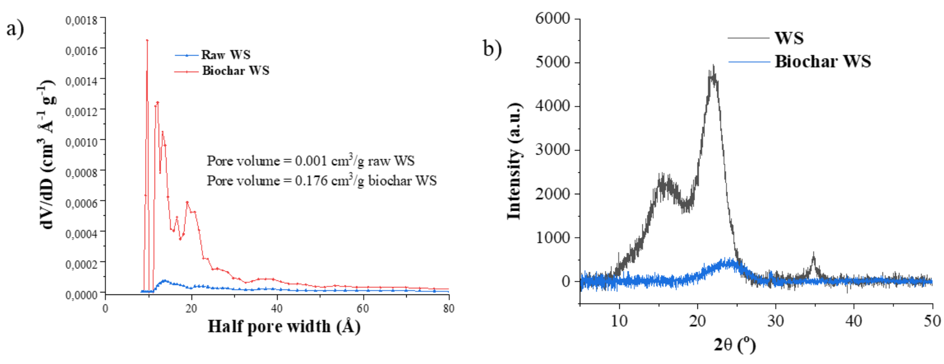


**Figure 1:** Pore volumes and XRD analysis of WS and biochars WS

## Results of BMP experiments

In figures 2 and 3, the main characteristics of the BMPs are presented, in which WS and biochars WS were added when using glucose and syringic acid or phenols, as substrates, respectively.

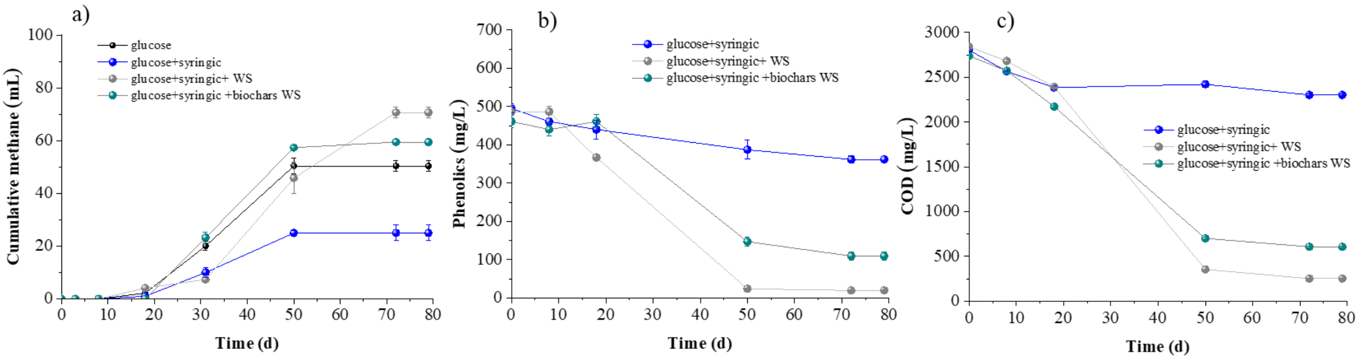


**Figure 2:** Cumulative $CH_4$ production (a), phenolics degradation (b) and COD reduction (c) in BMPs supplemented with WS and biochars WS, using glucose and syringic acid as substrate.

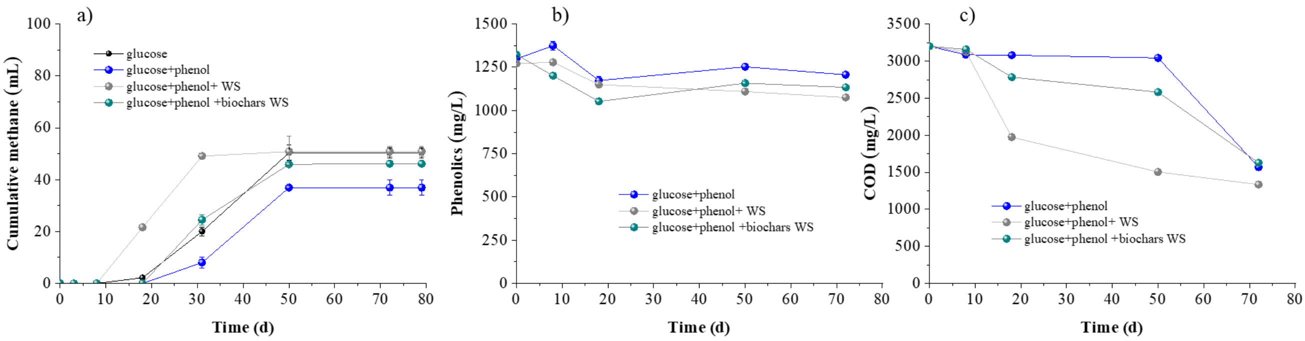


**Figure 3:** Cumulative $CH_4$ production (a), phenolics degradation (b) and COD reduction (c) in BMPs supplemented with WS and biochars WS, using glucose and phenol as substrate

The experiments of glucose with syringic acid showed that addition of raw WS as well as biochars, enhanced methane generation (fig. 2a), which was highest in the experiments with raw WS addition, accompanied by the highest phenols degradation and COD reduction (fig.2c). COD reduction was due to the consumption of VFAs produced, during the experiment. In the case of biochars, it seems that their higher surface area compared to the surface area of raw WS, did not promote methanogenesis.

In the case of phenol, addition of raw WS as well as biochars did not enhance cumulative methane generation (fig.3a), as in the case of syringic acid, but addition of WS enhanced only the rate of methane production. Furthermore, addition of WS or biochars did not promote the degradation of phenolics (fig.3b), but only glucose was degraded, as also confirmed by COD reduction (fig. 3c).

## Literature


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