BIO-OIL FROM SWEET POTATO WASTE APPLIED AS ANTIBACTERIAL AGENT

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ABSTRACT

This study investigated the antibacterial effect of bio-oil derived from sweet potato leaves. Pyrolysis was conducted at 550 °C, with a heating rate of 10 °C/min. The aqueous fraction of the bio-oil was collected and diluted to evaluate antimicrobial activity at concentrations ranging from 0.78% $v.v^{-1}$ to 25% $v.v^{-1}$. The results showed a reduction in bacterial growth as bio-oil concentration increased. Analysis of the composition of the aqueous fraction revealed the predominant presence of acetic acid and methanol. These findings corroborate previous studies, highlighting the potential of bio-oils as antibacterial agents and identifying acetic acid as a critical component in the antimicrobial activity of these products.

Keywords: Pyrolysis. Bio-oil. Antibacterial. Petroleum water.

1 INTRODUCTION

The inadequate disposal of agro-industrial waste has been associated with several environmental problems, including the emission of greenhouse gases. Rio Grande do Sul, the second largest producer of sweet potatoes in Brazil [1], generates different residues from this crop, especially the leaves. A promising strategy for using this waste is the application of thermochemical technologies, such as pyrolysis. Pyrolysis involves heating the material to temperatures between 300 ºC and 650 °C without oxygen, producing products such as biochar, bio-oil, and biogas [2]. Bio-oil, a complex mixture of chemical compounds, can be divided into two fractions: aqueous and organic. Studies indicate that bio-oil represents a valuable source of chemicals and exhibits potential as an insecticide, antifungal, and antibacterial [3,4].

In the oil and gas industry, water is produced during extraction, which contains bacteria such as *Bacillus cereus* and *Achromobacter insolitus.* These bacteria cause obstructions in equipment and pipes due to the ability to form biofilms. They also present a high tolerance to antimicrobials, representing a significant challenge for the oil industry [5,6] . Additionally, secondary oil recovery requires water/gas injection to move the oil from the well to the platform surface. In this sense, the water produced is often reused; however, due to microbial contamination in the well, treatments with biocides are used [7]. In this context, this work aims to enable the sweet potato waste biorefinery, exploring the potential of bio-oil generated from sweet potato leaves to inhibit the microbial growth of these bacteria, providing a way to add economic value to these wastes.

2 MATERIAL & METHODS

Pyrolysis: The bio-oils were obtained through the thermochemical treatment of dried sweet potato leaves. The pyrolysis process was carried out at 550ºC with a heating rate of 10ºC/min remaining at this temperature for 60 min. The bio-oil produced was divided into two phases: organic and aqueous. The aqueous phase was then employed to explore its antibacterial activity.

Bio-oil composition analysis was carried out by high-performance liquid chromatography (HPLC) [8].

Bio-oils: The bio-oil aqueous fractions for leaf (AFBO) were diluted in autoclaved distilled water. The final concentrations in the microplate wells were 25,12.5,6.25,3.13,1.56 and 0.78% $v.v^{-1}$.

Microbial growth analysis: *Bacillus cereus* and *Achromobacter insolitus* strains were cultivated in Tryptone Soy Agar (TSA) for 24h. Afterward, cell suspensions were produced with turbidity adjusted according to the 0.5 Mc Farland scale standard [9]. The final suspension was diluted in Tryptone Soy Broth (TSB) to a final concentration of $5X10^5$ UFC. In a 96 well microplate, 100 µl of this suspension were inoculated into each well, along with 100 µl of bio-oil. Positive growth control wells were performed. The plates were incubated at 37ºC for 24 hours; the microbial growth was quantified through optical density at a wavelength of 570 nm.

3 RESULTS & DISCUSSION

Figures 1 and 2 show the optical density with positive control for *Bacillus cereus* and *Achromobacter insolitus*, respectively. In both cases, increasing bio-oil concentration resulted in a reduction of microbial growth. The average optical density for the growth control was 0.1635 for *Bacillus cereus* and 0.305 for *Achromobacter insolitus*.

For *Bacillus cereus* a significant growth reduction was observed for bio-oil concentration of 3.13 % and higher. For *Achromobacter insolitus*, no reductions were observed at a concentration of 0.78 %, the reduction was only significant from concentrations of 6.25 %. This behavior of reduction in the optical density of bacteria demonstrates the potential of these bio-oils as antibacterials.

The compounds detected through HPLC analysis in the bio-oil before dilutions showed acetic acid as predominant, with a concentration of 26.8 g L^{-1} , however, methanol (16.03 g L^{-1}) was also found in a high proportion.These two compounds are generated through the thermal degradation of hemicellulose present in sweet potato leaves [10]. MAHMUD et al. (2016)[11] verified the antibacterial activity of concentrated bio-oil from pineapple solid biomass obtained through pyrolysis at 600°C against *Esterichia coli.* The authors also detected high concentrations of acetic acid (22.12 g L^{-1}) and suggested that acetic acid contributes to the antimicrobial action. However, it is worth highlighting that other compounds which were not quantified may be associated with the detected antibacterial activity.

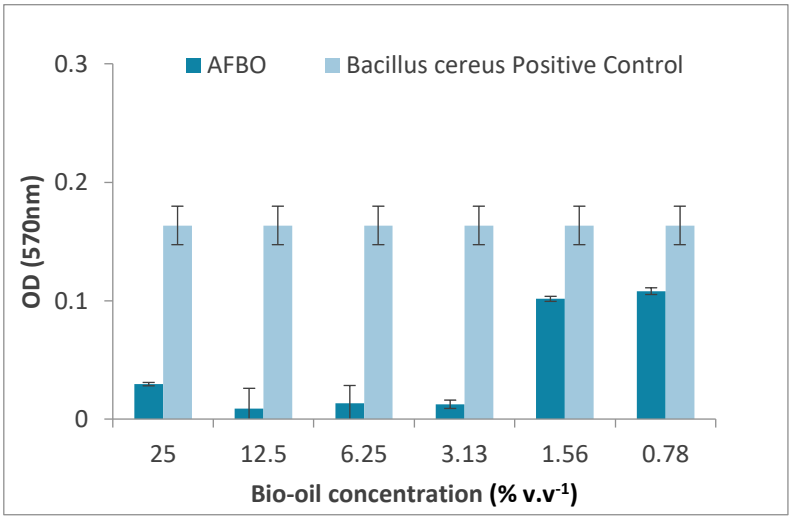

Figure 1 Bacterial growth *Bacillus cereus*.

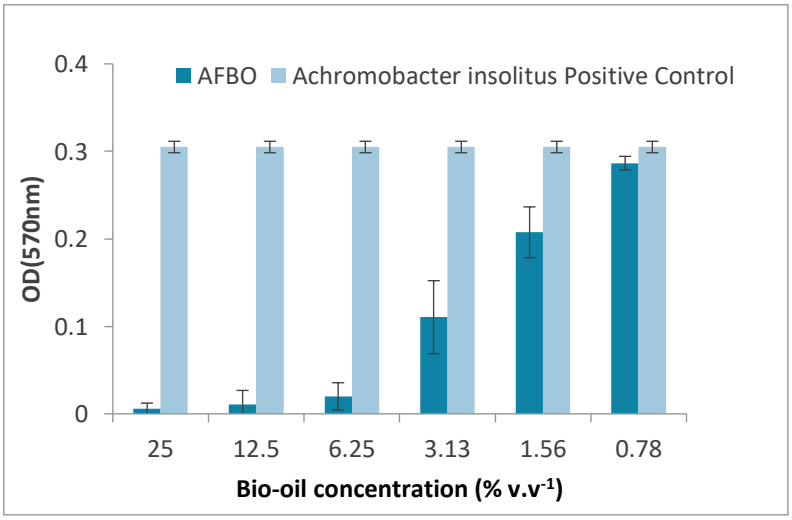

Figure 2 Bacterial growth *Achromobacter insolitus*

4 CONCLUSION

This study highlights the use of pyrolysis for the added-value of agro-industrial waste. The results demonstrate that the bio-oil generated have antimicrobial potential, due to the significant reduction in bacterial growth for the bacteria tested. The predominant presence of acetic acid and methanol in bio-oils reinforces the relationship between these compounds and the observed antimicrobial activity. These findings contribute to the search for sustainable solutions in the management of agro-industrial waste

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