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Assessment of the phenol adsorption potential of biocarbons: a focus on hydrochars

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INTRODUCTION

Gallic Acid or 3,4,5 – trihydroxybenzoic acid constitutes a phenolic acid that can be detected in vascularized plants and found in many lignocellulosic by-products. Some phenolic acids considered to be as natural preservatives in food products for their antiseptic properties, but some other can cause adverse toxic effects to aquatic organisms, at concentrations between 10–100 mg/L. Adsorption is a mechanism that can be used for the removal of both organic and inorganic chemical compounds that cause pollution. Hydrochar is a solid product produced from Hydrothermal Carbonization treatment (HTC) which is characterized as a carbon-like, ecological material with many applications such as soil conditioner and filter of adsorbent of heavy metals, phenols, and dyes. In addition, Biochar is a solid carbon–enriched porous product of thermal pyrolysis that can be used as an environmentally friendly adsorbent and biofilm carrier. In this study hydrochar of HTC of anice waste and biochar from cacao was tested for their ability to adsorb Gallic acid under three different temperatures. Other parameters that were also determined were pH and Electrical Conductivity of the liquids.

METHODS

Phenol adsorption experiments: Six experiments took place for Gallic Acid of 100mg/l adsorption with 2 different biocarbon adsorbents, Hydrochar of Hydrothermal Carbonization (HTC) of Anice wastes and Biochar of Cacao. In each experiment, 95 ml of Gallic Acid solution and 5g of the cleaned and dried biocarbon were placed in a conical flask. Each mixture was mixed and shaken on a magnetic stirrer for the whole duration of each experiment. The experiments occurred under 3 different temperatures (25°C, 35°C, 45°C) and were conducted for two hours residence time. The sampling process occurred every 15 minutes from the start of each experiment and each sample was centrifuged before its analysis.

Analysis of phenols: The analysis of phenols was performed using the Folin method with Folin reagent and Na_2CO_3. To determine the Gallic Acid adsorption after the analysis, all the concentrations of the samples were measured with a Hach Lange DR 3900 Spectrophotometer.

Table 1. Experimental conditions

6 experiments of Gallic Acid Adsorption		
Experiment #	Description	Short name
Experiment 1	Gallic Acid Adsorption with Hydrochar of Anice waste @ 25 at °C	T1
Experiment 2	Gallic Acid Adsorption with Hydrochar of Anice waste @ 35 at °C	T2
Experiment 3	Gallic Acid Adsorption with Hydrochar of Anice waste @ 45 at °C	T3
Experiment 4	Gallic Acid Adsorption with Biochar of Cacao waste @ 25 at °C	T4
Experiment 5	Gallic Acid Adsorption with Biochar of Cacao waste @ 35 at °C	T5
Experiment 6	Gallic Acid Adsorption with Biochar of Cacao waste @ 45 at °C	T6

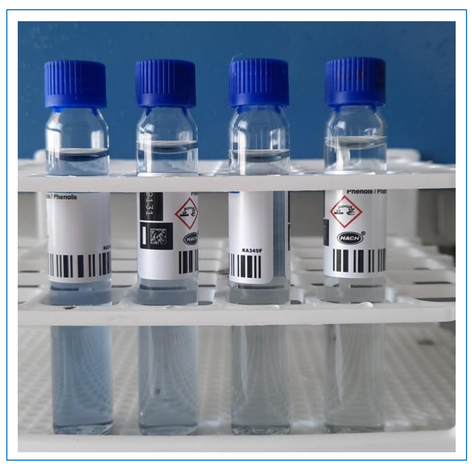

Fig. 1. Phenol Adsorption with Folin Method

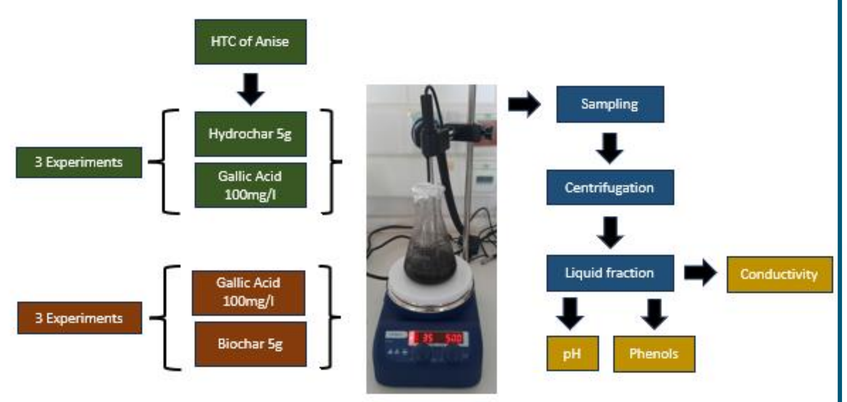

Fig. 2. Experimental design

RESULTS AND DISCUSSION

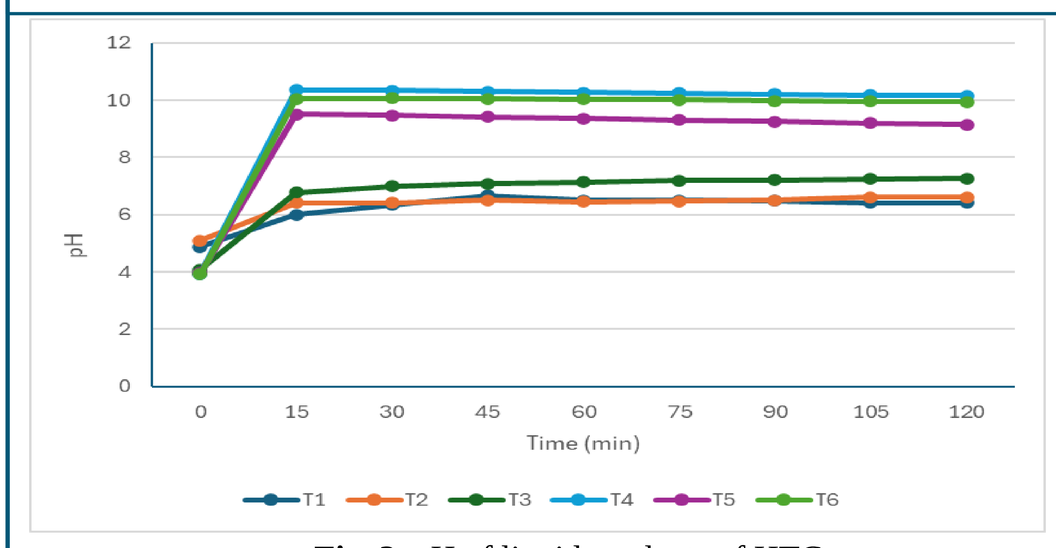

Fig. 2. pH of liquid products of HTC

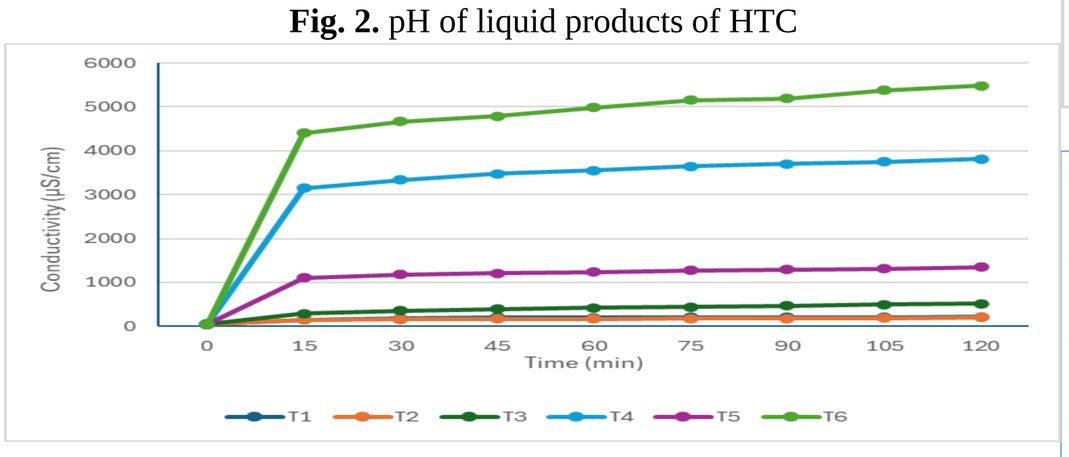

Fig. 3. Electrical Conductivity of the liquid products

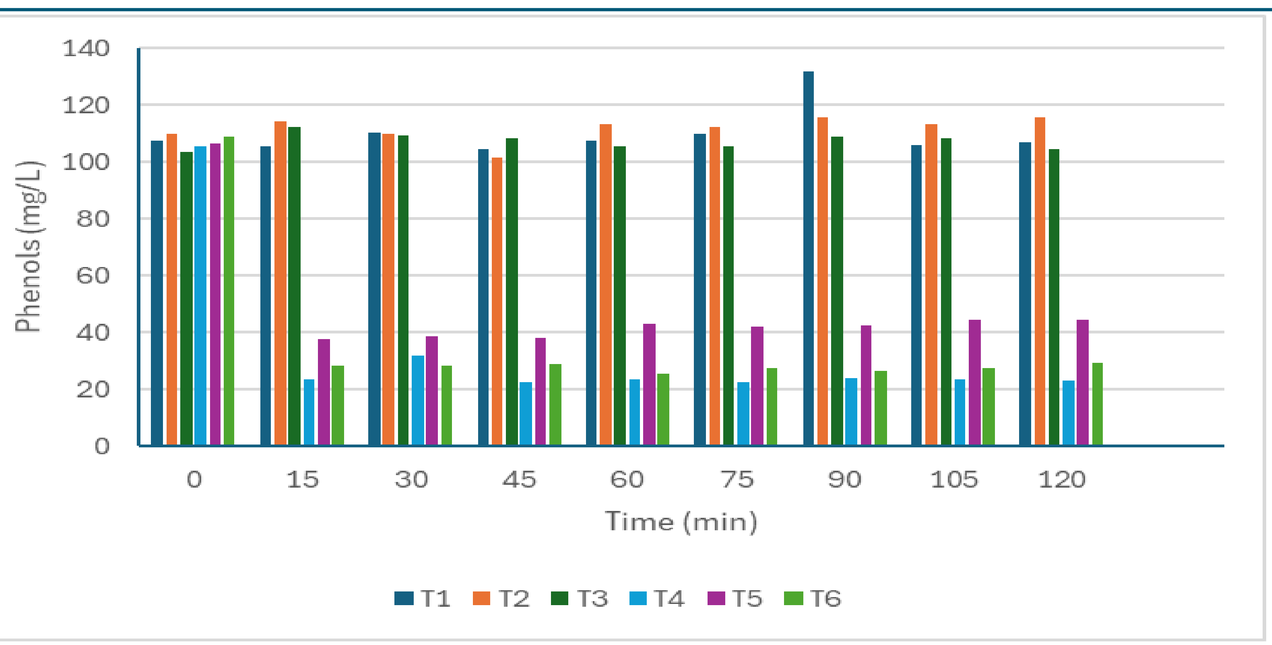

Fig. 4. Gallic Acid concentration in liquid products

- The experiments T1, T2 and T3 showed minimal to non-existent adsorption with the hydrochar as adsorbent.
- The experiments T4, T5 and T6 noted from 58% to 79% with the biochar as adsorbent.
- The different temperatures didn't seem to affect in a great extent the adsorption process.
- The pH rates seemed more alkaline for the experiments with Biochar while the pH rates in the experiments with hydrochar were more neutral.
- .The Conductivity of the experiments T4, T5 and T6 of biochar was significantly higher than the ones with hydrochar.

CONCLUSIONS

- The biochar seems to be better phenol adsorbent compared to the hydrochar.
- The pH and Conductivity may have influenced positively the adsorption process with the biochar.
- The biochar could adsorb Gallic acid from 64% to 78% from the first 15 minutes.
- Further research needs to be performed for a better activation of the hydrochar before its use for adsorption.

References:

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