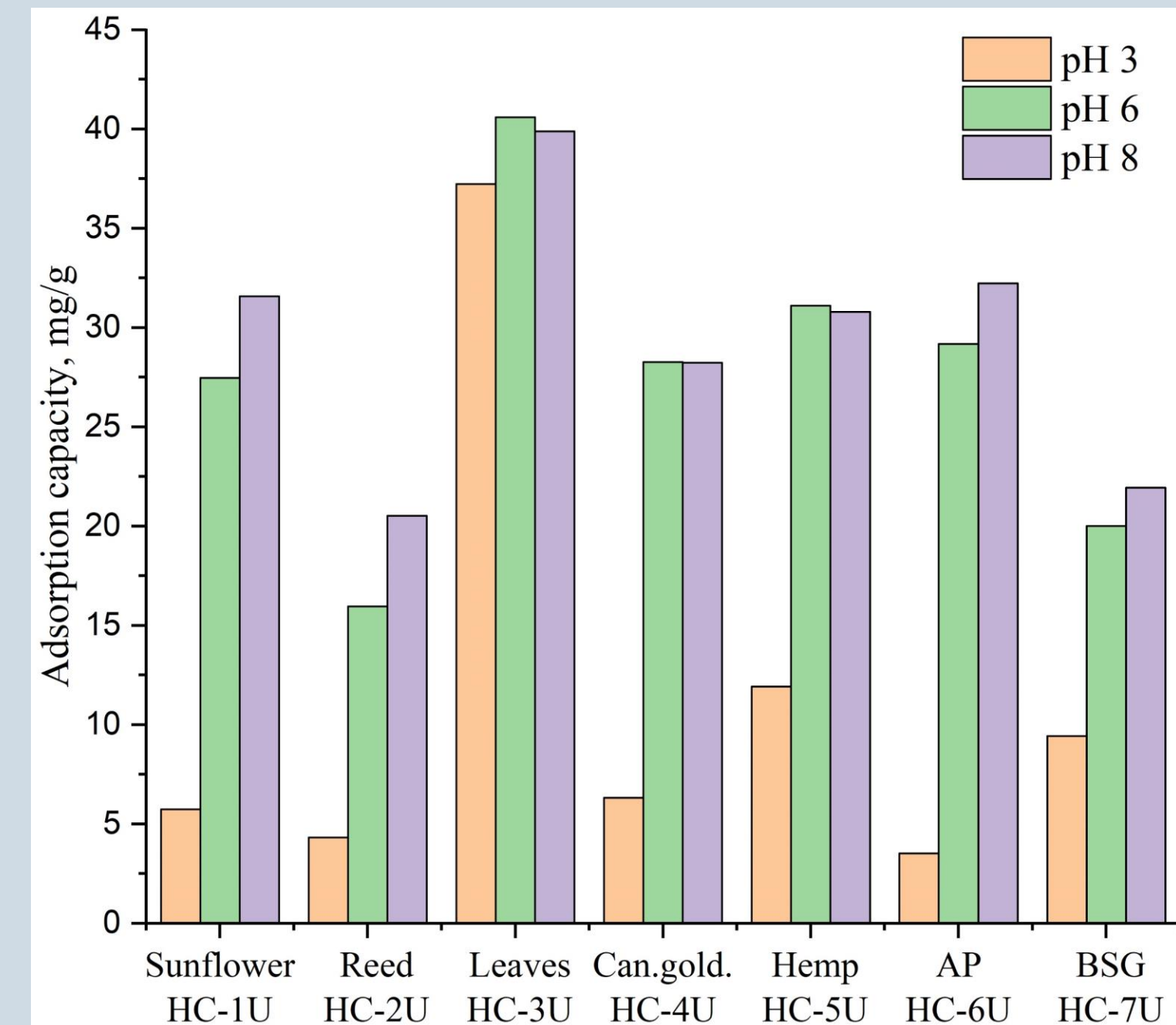
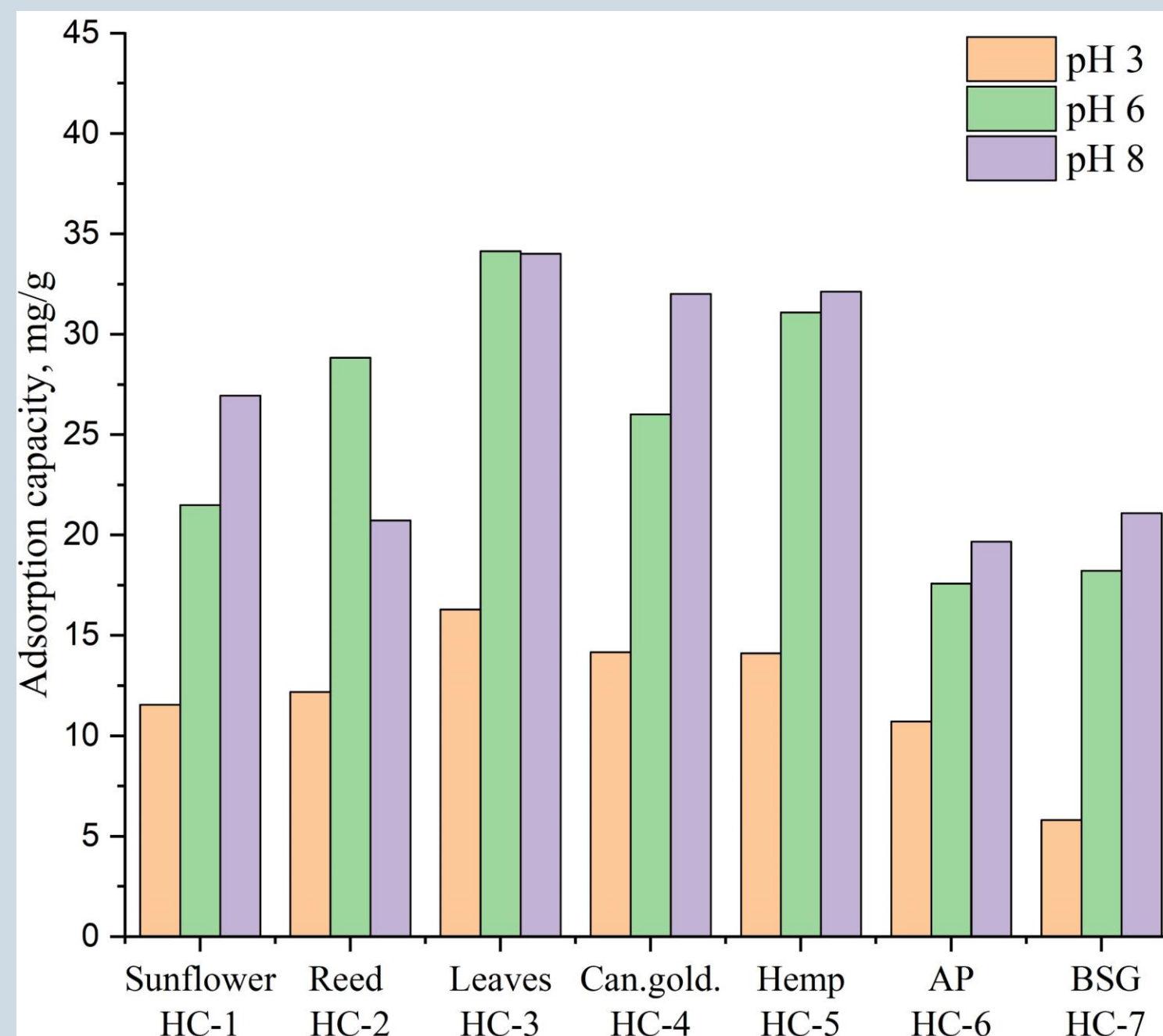
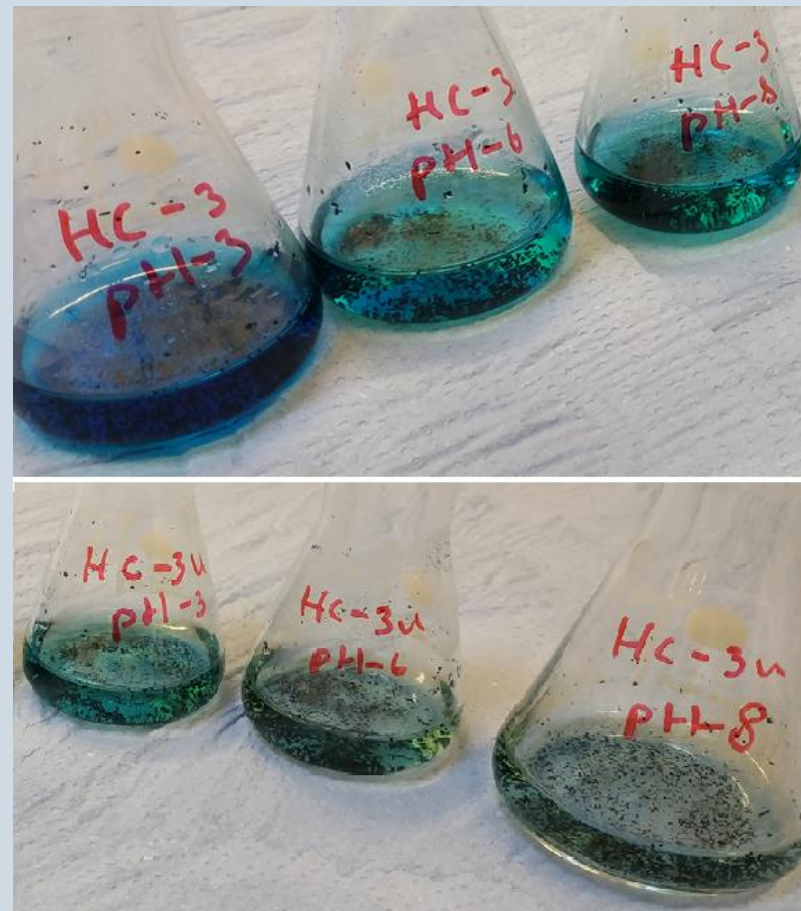


Urea treatment changes hydrochar properties significantly.



Water-treated hydrochars are more aromatic and suitable for carbon sequestration. Urea-treated hydrochars are better for soil amendment.

Introduction

Climate change demands urgent action, and agriculture remains a major contributor to global greenhouse gas emissions. Biochar can be a vital solution for waste reduction, soil improvement and carbon sequestration. Hydrothermal carbonization (HTC) offers an efficient method to produce hydrochar from wet biomass at low operation temperatures. The study was conducted with 7 biomasses – sunflower, reed, leaves, Canadian goldenrod, hemp, apple pomace (AP) and brewer's spent grain (BSG).

Methodology

Hydrothermal carbonization was performed at 220 °C for 45 minutes in water or urea solution using microwave-assisted mineralization system (MARS 6). Both biomasses and obtained hydrochars were studied. ATR-FTIR, an ultimate analysis (CHNS-O), determination of pH point of zero charge (pH_{PZC}) and adsorption of Methylene blue at pH 3, pH 6 and pH 8 (by UV-Vis spectrophotometry) were used to characterize properties of biomasses and obtained hydrochars.

Results

HTC leads to H/C ratios which are much closer to 1 indicating increasing aromaticity of obtained hydrochars (Fig.1). HTC in urea solution leads to much less degree of dehydration and less aromaticity in comparison to water-treated hydrochars (Figs. 1 and 2). pH_{PZC} of hydrochars, obtained by water-treatment, lies in acidic regions (Table 1). Adsorption capacity rises rapidly from pH 3 to pH 6 (2-3 times higher for water-treated; 2-10 times higher for urea-treated). Water-treated hydrochars (except of BSG) adsorb better at low pH. Obtained results support assumption about adduction reactions between urea and biomass components.

Table 1. The pH_{PZC} of water- and urea-treated hydrochars

	Hydrochar, water-treated	pH _{PZC}	Hydrochar, urea-treated	pH _{PZC}
Sunflower	HC-1	4.6	HC-1U	6.5
Reed	HC-2	4.4	HC-2U	6.7
Leaves	HC-3	5.8	HC-3U	7.3
Canad.gold.	HC-4	6.3	HC-4U	7.6
Hemp	HC-5	6.6	HC-5U	7.2
AP	HC-6	4.0	HC-6U	6.8
BSG	HC-7	5.6	HC-7U	6.5

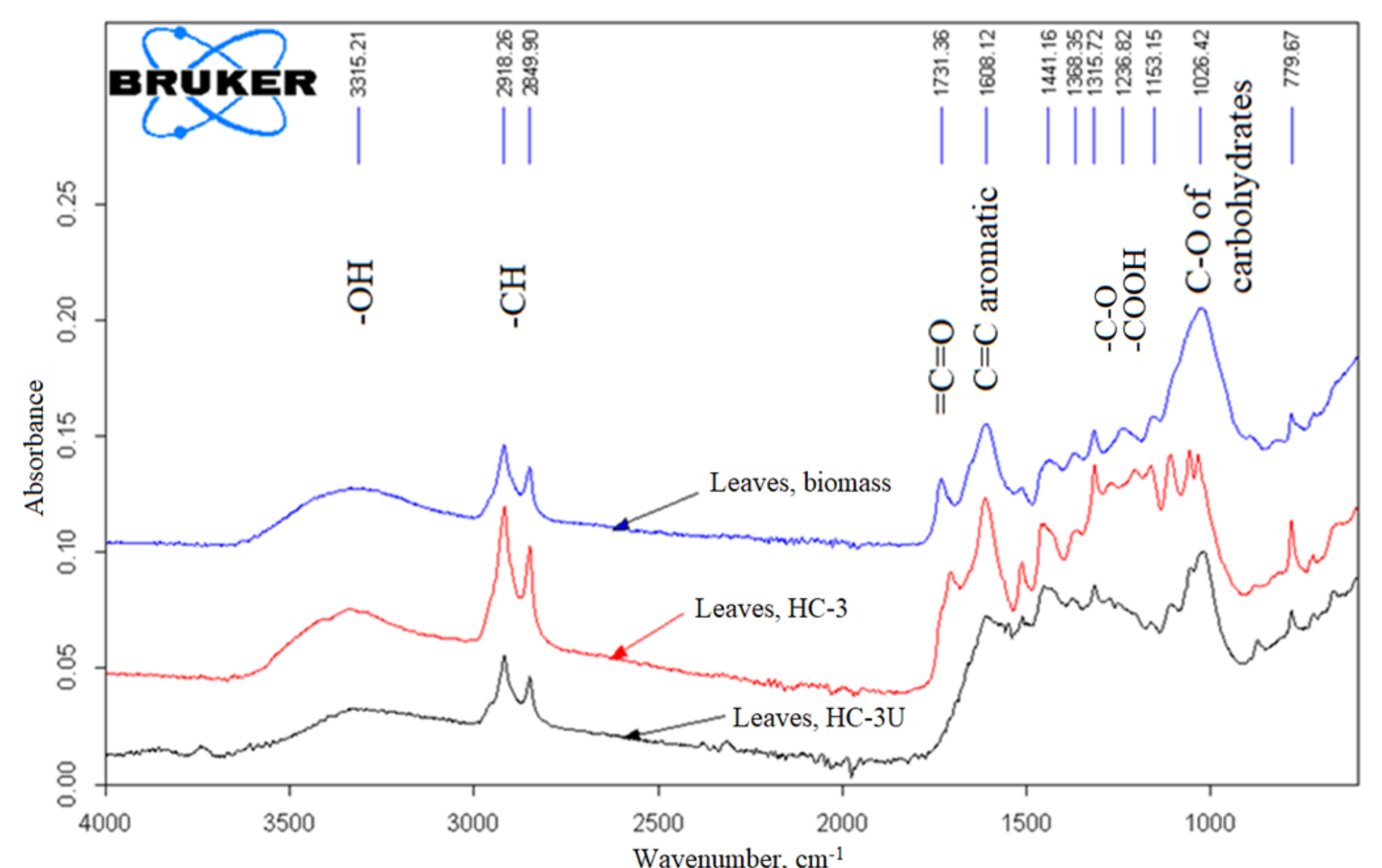
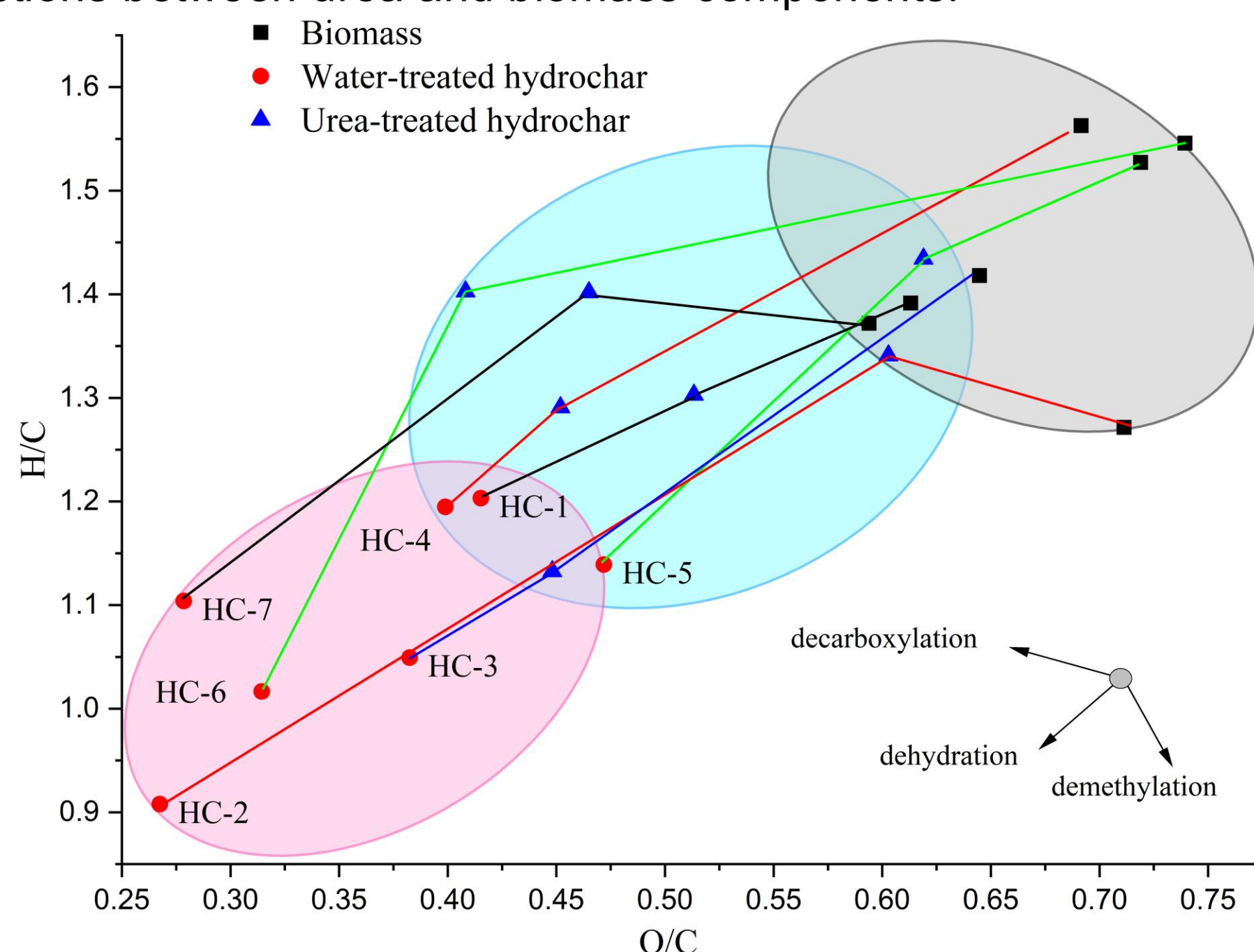


Fig.1. Van Krevelen diagram for biomasses and related hydrochars

Fig.2. ATR-FTIR spectra of leaves biomass and related hydrochars