THE INFLUENCE OF PYROLYSIS TEMPERATURE ON THE PROPERTIES OF BIOCHAR DERIVED FROM WHEAT STRAW

Nina Đukanović[1], Tamara Apostolović[1], Jasmina Anojčić[1], Sanja Mutić[1], Tijana Marjanović Srebro[1], Snežana Maletić[1], Jelena Beljin[1]

[1]Department of Chemistry, Biochemistry and Environmental Protection, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia,
nina.djukanovic@dh.uns.ac.rs

BIOCHAR PRODUCTION

Biochar – carbon-rich material.

Can be obtained from various organic feedstock.

Slow pyrolysis - thermal process of decomposition of organic matter in the absence of oxygen (temperature between 350 and 700°C)

Organic matter is converted into :

- **biochar**,
- gases,
- liquid product.

Due to its diverse properties, biochar has potential for environmental, industrial and agricultural applications.

Its specific application depends on the properties of the biochar, which are influenced by pyrolysis conditions such as temperature, retention time, and feedstock type.

BIOCHAR PRODUCTION

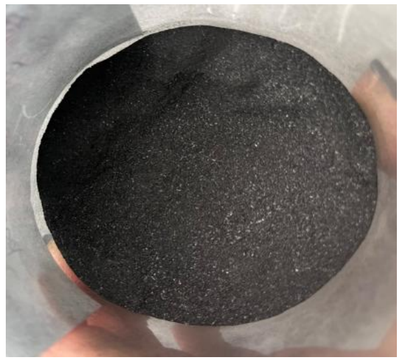
Wheat straw were collected on the agricultural plot immediately after harvest and chopped into small pieces using scissors.

The chopped materials were dried in an oven at 60 °C for 24 h and placed in a furnace (Nabertherm: higher than 30-3000 °C, Germany).

The pyrolizer was closed (to prevent oxygen flow) and heated to **400 and 700 °C** at a rate of 10 °C/min.

The samples were pyrolyzed in an inert atmosphere (argon), at an inert gas flow of 80 L/h.

After slow pyrolysis, the pyrolyzed material was allowed to cool to ambient temperature gradually.



This work aimed to examine the effect of pyrolysis temperature on the properties of biochars obtained by pyrolysis of wheat straw at temperatures of 400°C and 700°C, for 1 h in an inert atmosphere.

IMPORTANCE OF CHARACTERIZATION OF BIOCHAR - to understand its physical, chemical and structural properties

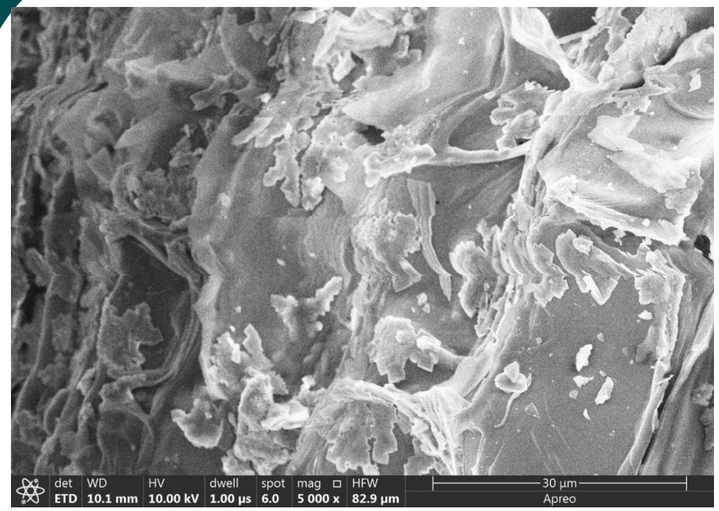
- Optimization of the application process
- Choosing optimal conditions
- Selecting the quantity to achieve maximum efficiency

CHARACTERIZATION

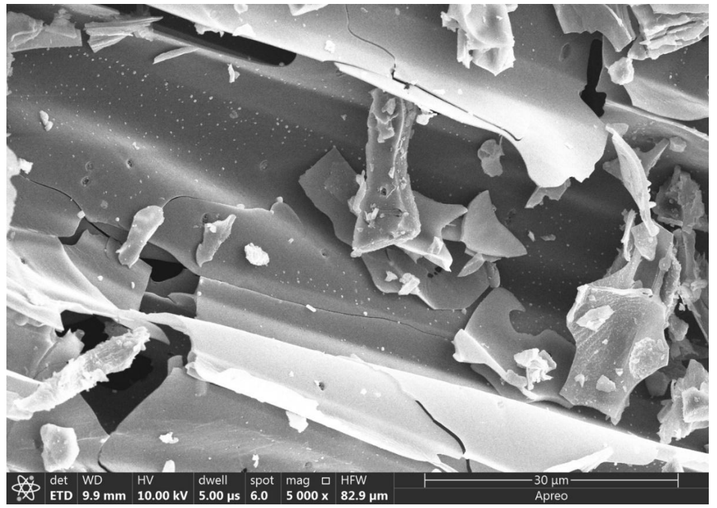
The biochars are labeled as **WS400** (produced on 400 °C) and **WS700** (produced on 700 °C)

- Brunauer-Emmett-Teller method (**BET**),
- scanning electron microscopy (**SEM**),
- energy-dispersive X-ray spectroscopy (**EDS**),
- **CHNS,**
- thermo-gravimetric analysis (**TGA**),
- **Raman** spectroscopy,

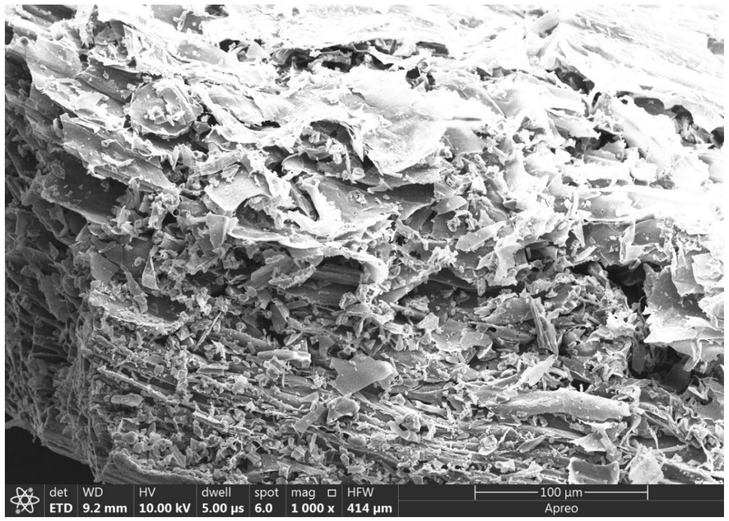
S E M & B E T



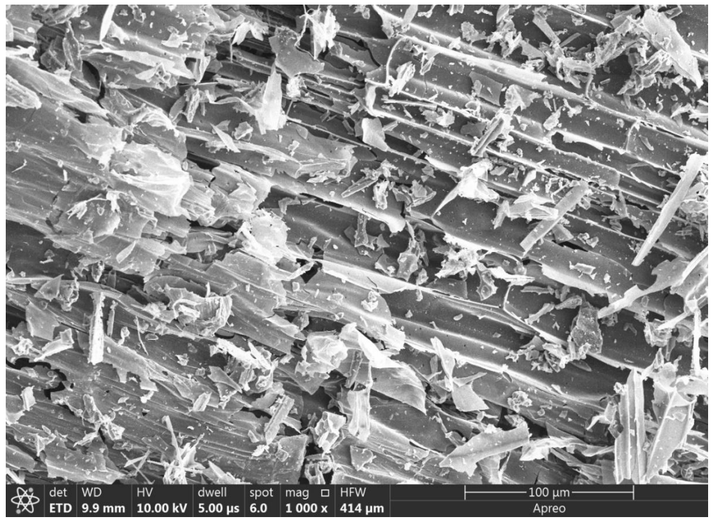
WS400 mag. 5000x



WS700 mag. 5000x



WS400 mag. 1000x



WS700 mag. 1000x

BET

3.68 m^2g^{-1} WS400

80.88 m^2g^{-1} WS700

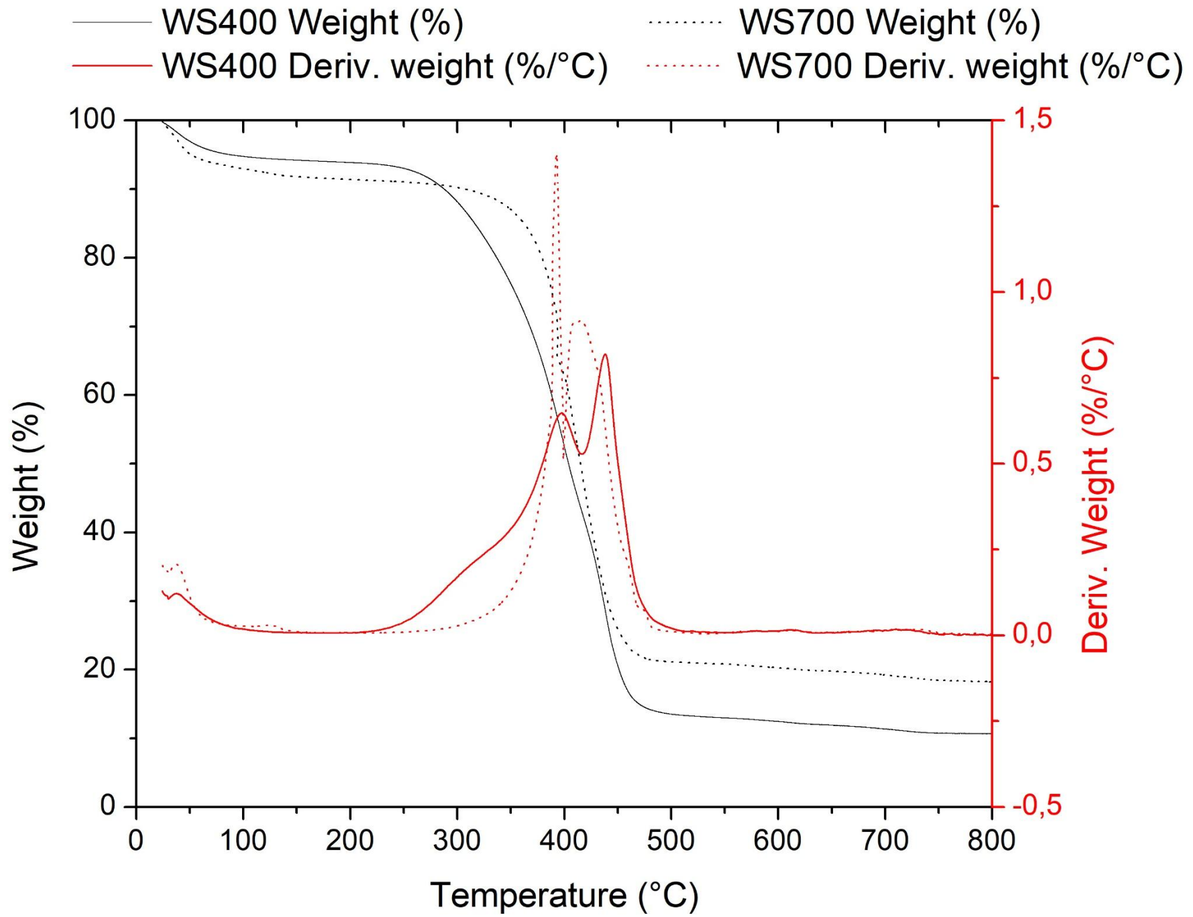
Temperature of pyrolisis ↑ **Specific surface area and porosity** ↑

CHNS & EDS

Parameters	WS400	WS700
C (% w/w)	66.7 ± 2.38	66.3 ± 2.23
H (% w/w)	4.30 ± 0.25	1.66 ± 0.01
N (% w/w)	1.41 ± 0.60	0.94 ± 0.07
S (% w/w)	2.84 ± 0.72	2.01 ± 0.32
O (% w/w)	8.47 ± 7.51	6.55 ± 2.53

- All other elements in the biochars contained mostly less than 1%, except Ca (1-2%) and Si (more than 1%).

TGA / dTG



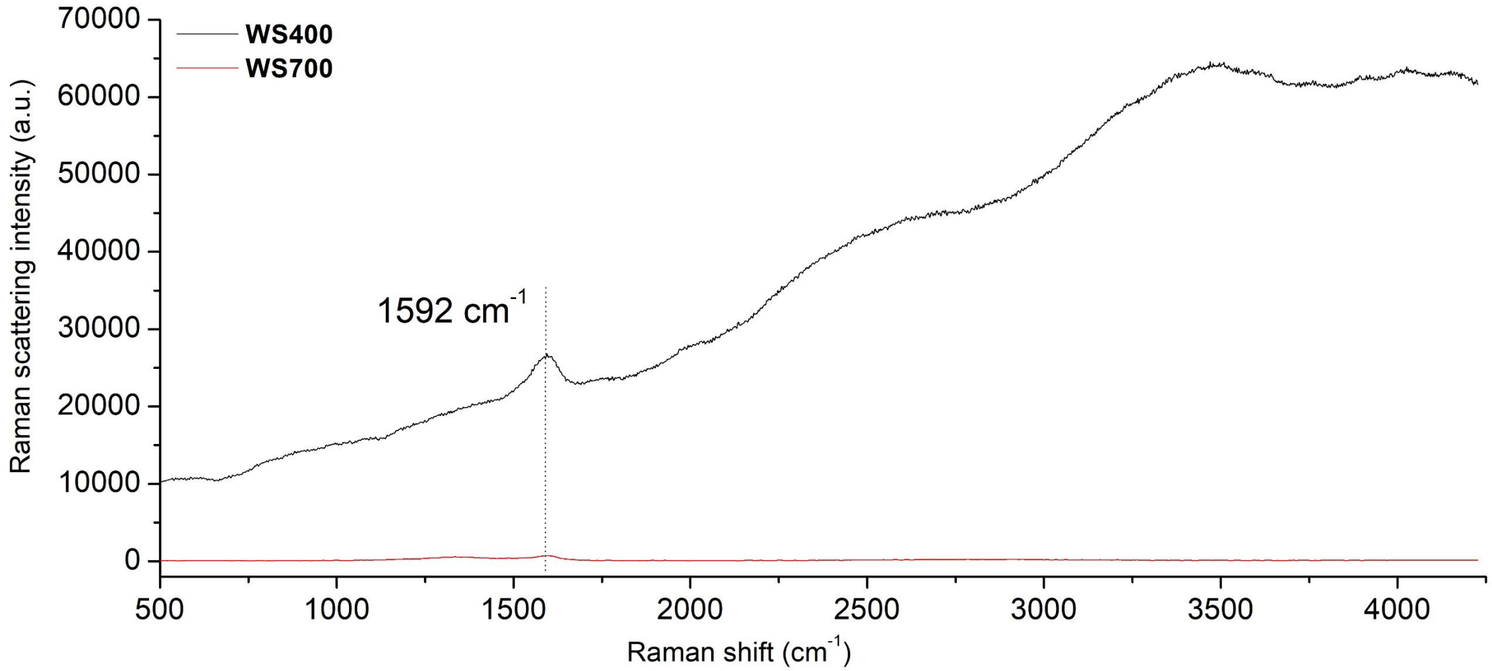
- The total weight loss during TGA was about 89% for WS400 and about 82% for WS700, with the highest thermal degradation observed between 300 and 500 °C.

The area under the TG/dTG curve is divided into five parts, which represent different degrees of resistance to thermal oxidation:

1. **moisture** (20-105 °C) - free water that is not chemically bound to the material structure;
2. **moisture and very labile organic matter (OM)** (105-200 °C) - residual water that is more tightly bound to the pores and surface of the sample, as well as small molecules (hydrocarbons, fatty acids, waxes);
3. **labile OM** (200-400 °C) - mainly polysaccharides;
4. **intermediate OM** (400-600 °C) - proteins and aliphatic compounds;
5. **recalcitrant OM** (600-800 °C) - lignins, polyphenols, and condensed aromatic structures.

RAMAN SPECTROSCOPY

- Raman spectral characteristics include the widths, positions, and intensity ratios of the G (graphite) and D (defect) bands.



- Non-specific Raman spectra;
- the D band is not visible (normally appears as a broad peak at around 1325 - 1380 cm^{-1});
- The G band is barely visible (1592 cm^{-1});
- It was not possible to calculate the I_D/I_G ratio

CONCLUSION

- ✓ Higher pyrolysis temperature (700 °C) significantly improves porosity, specific surface area, and thermal stability of biochar.
- ✓ Wheat straw biochar contains high C and O
- ✓ Raman spectra show low graphitization and low structural defects, especially in WS700.
- ✓ WS700 shows potential for use in soil remediation, water treatment, and high-temperature industrial processes.

Thank you for attention!

EnvirChar

Science Fund of the Republic of Serbia

@envirochar

envirochar.pmf.uns.ac.rs

Science Fund of the Republic of Serbia

This research was supported by the Science Fund of the Republic of Serbia, #10810, Sustainable solutions in environmental chemistry: exploring biochar potential–EnviroChar.