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Waste Valorization III

Wrocław University of Science and Technology

Influence of pyrolysis conditions on the properties of bio-chars produced from aquatic biomass – alga and hornwort

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Hornwort and alga

Hornwort (*Ceratophyllum demersum*)

- fast growing freshwater aquatic biomass
- high ability for nutrient acumulation
- eutrophication of waters

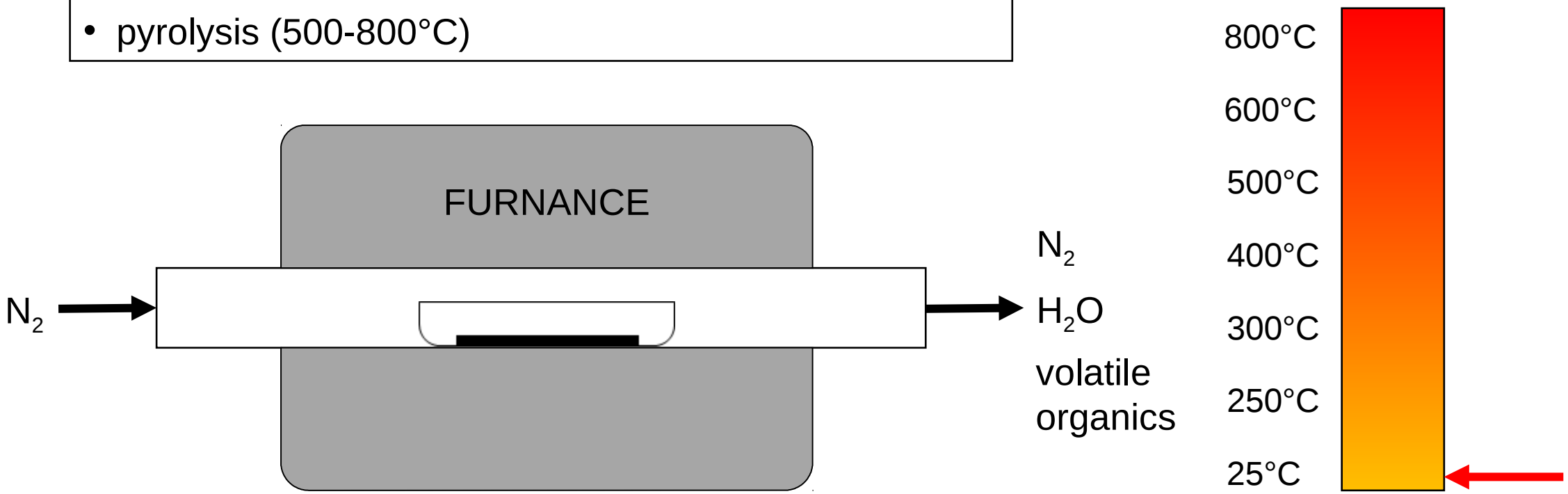
Alga (*Cladophora glomerata*)

- fast growing abilieties
- eutrophication of waters

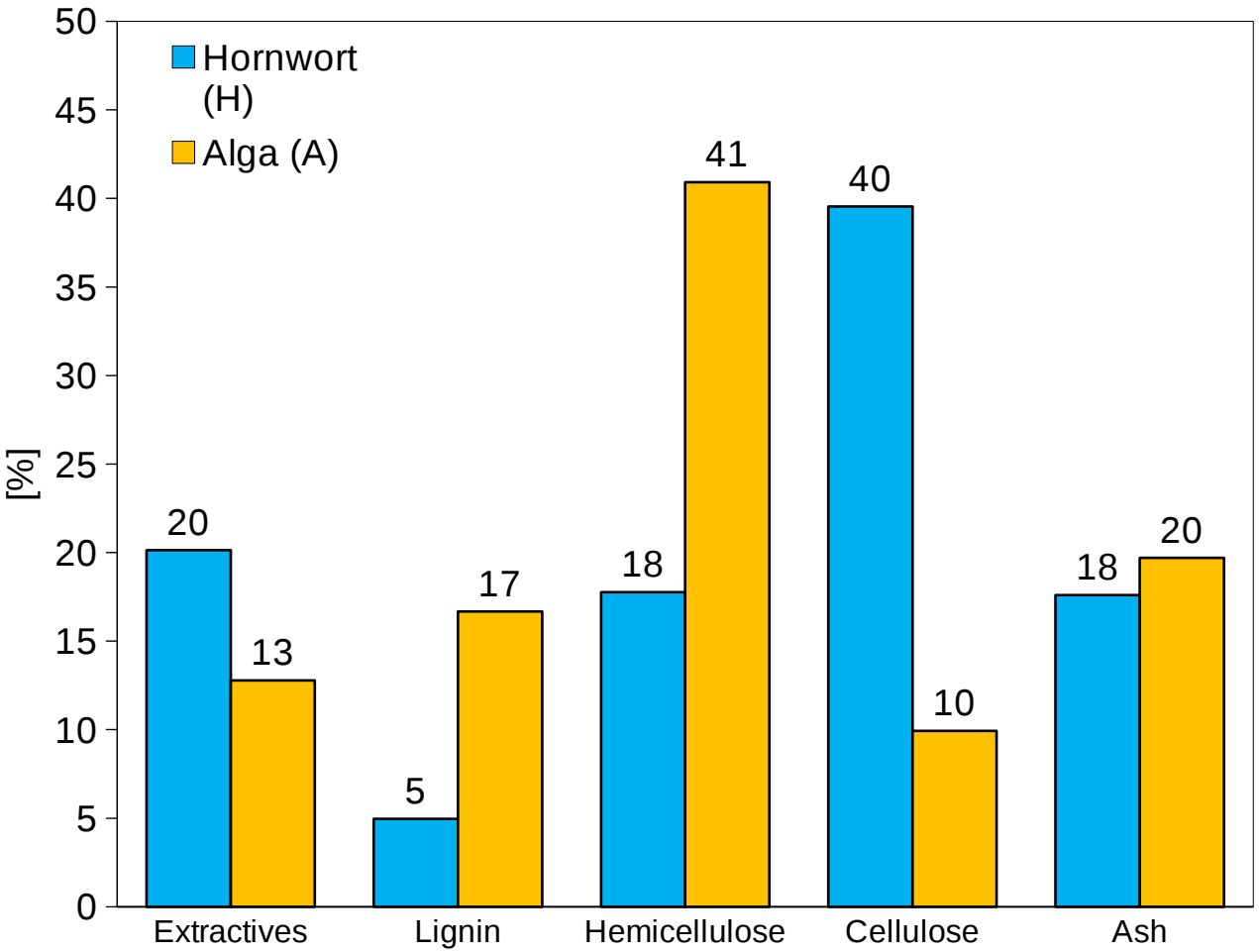
Thermochemical conversion

PROCESS PARAMETERS

- inert atmosphere (20 dm^3/h N_2 flow)
- heating rate 10°C/min, residence time 1 hour
- pyrolysis (500-800°C)



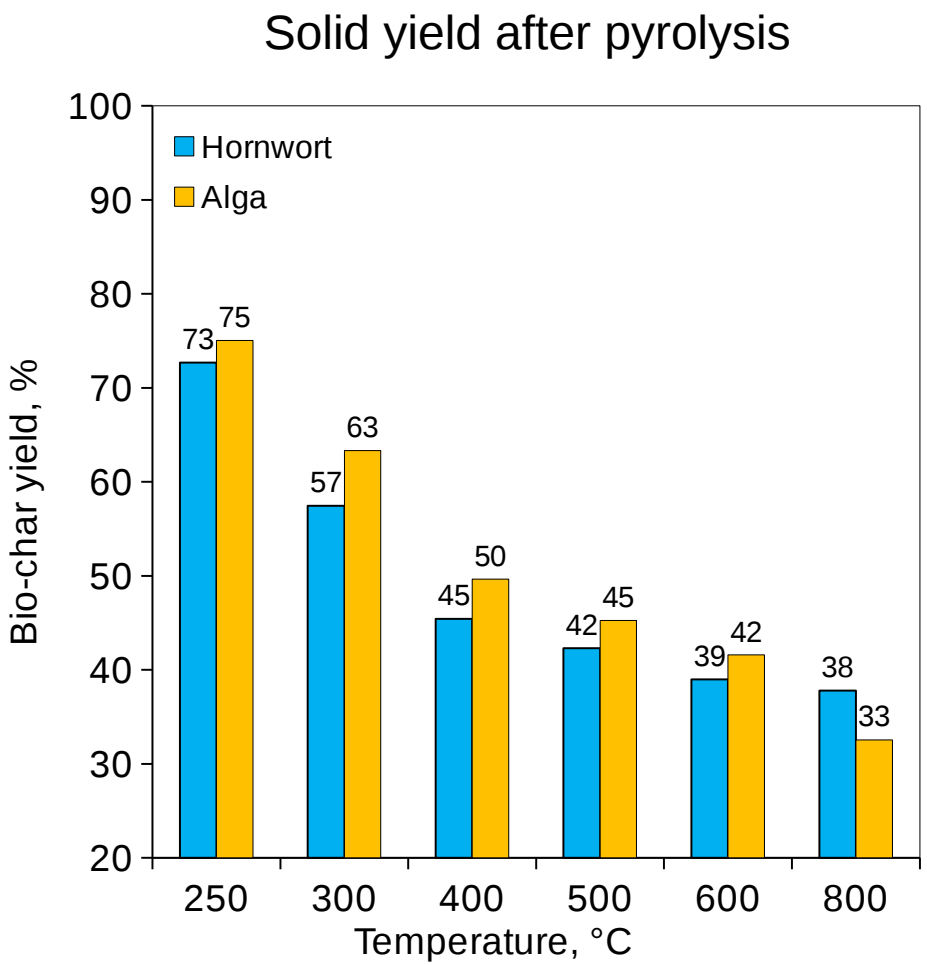
Hornwort and alga – chemical composition characterization

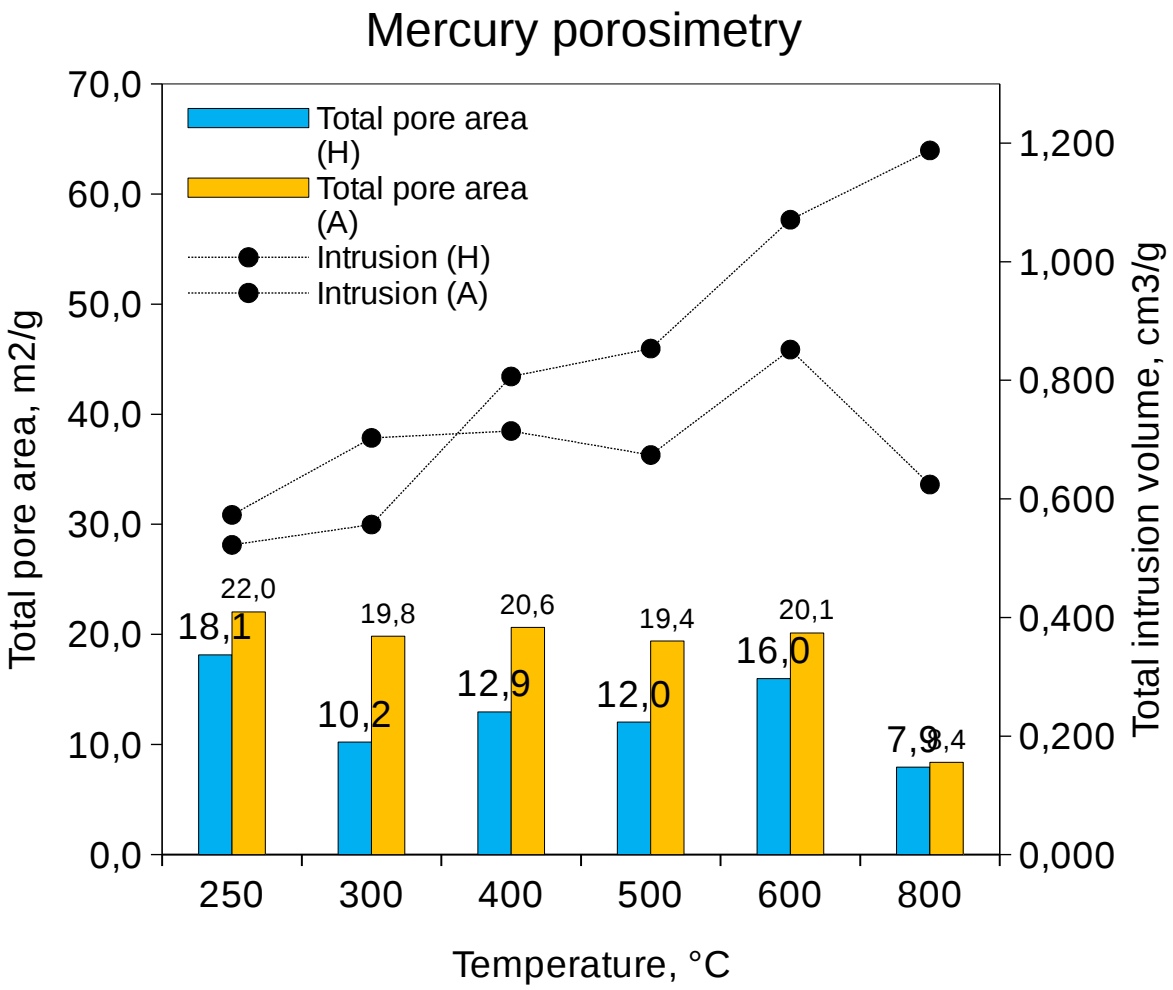


- high amounts of ash (~20%) in both hornwort and alga
- significant difference in cellulose and hemicellulose contents
- over 3 fold higher amount of lignin in alga in comparison to hornwort
- higher extractives amount (20%) in hornwort than in alga (13%)

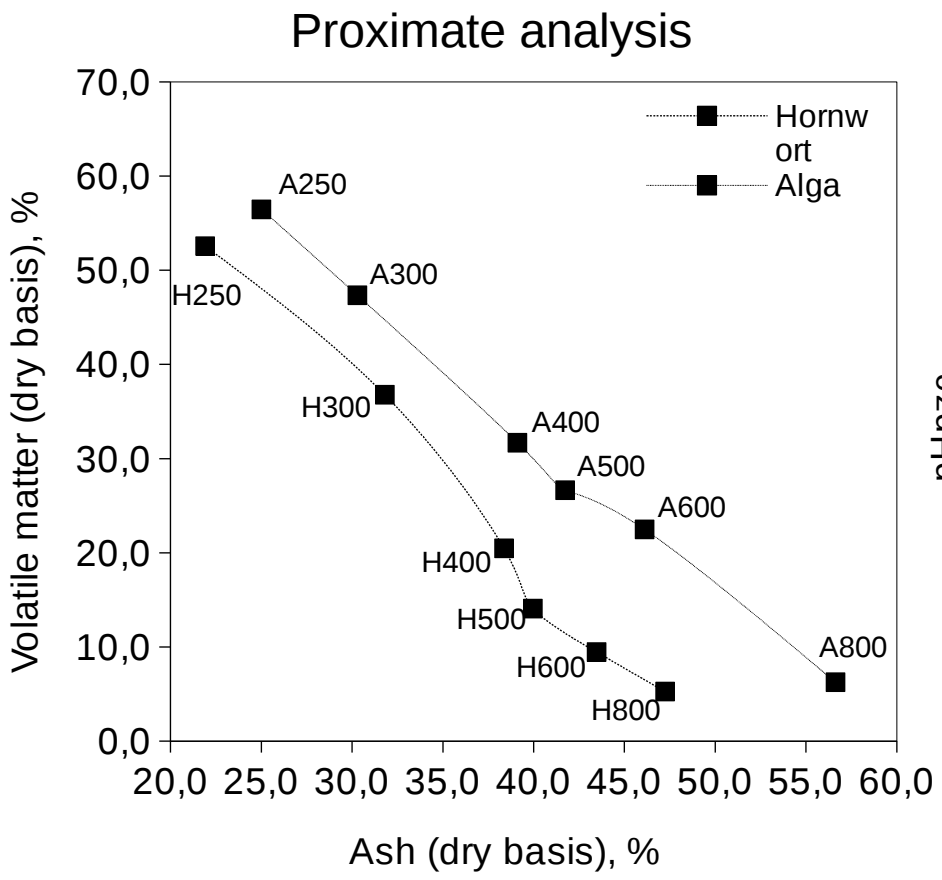
A. Ayeni, O. Adeeyo, O. Oresegun, T. Oladimeji, Compositional analysis of lignocellulosic materials: Evaluation of an economically viable method suitable for woody and non-woody biomass, Am. J. Eng. Res. (2015).

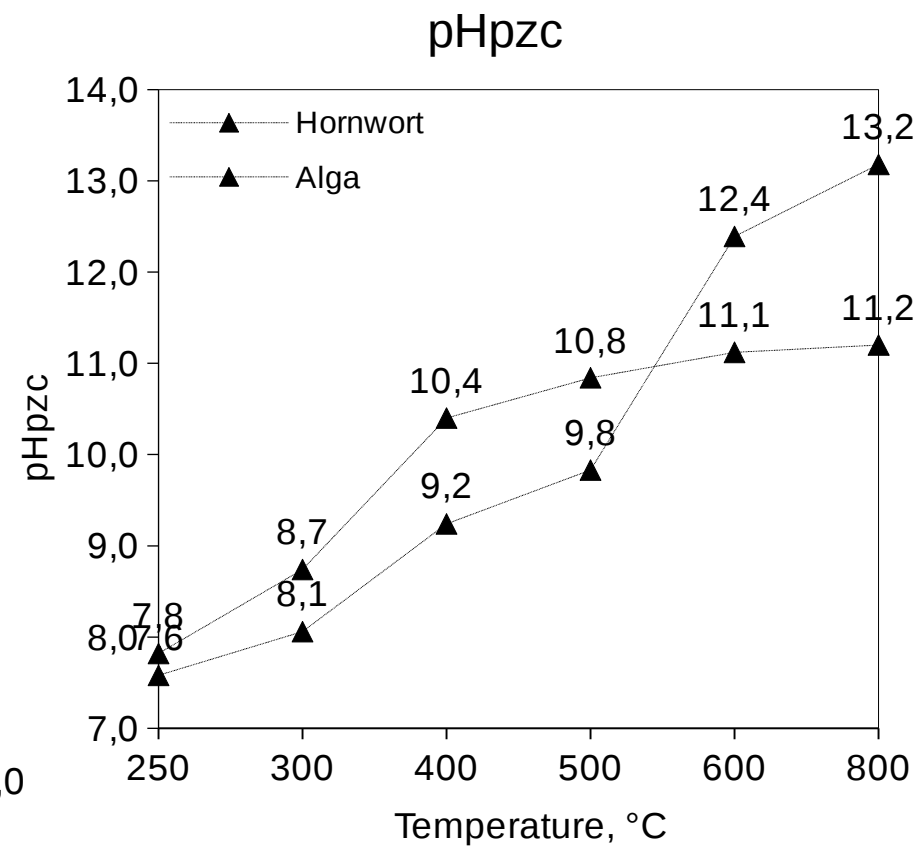
Hornwort and alga – chemical composition characterization



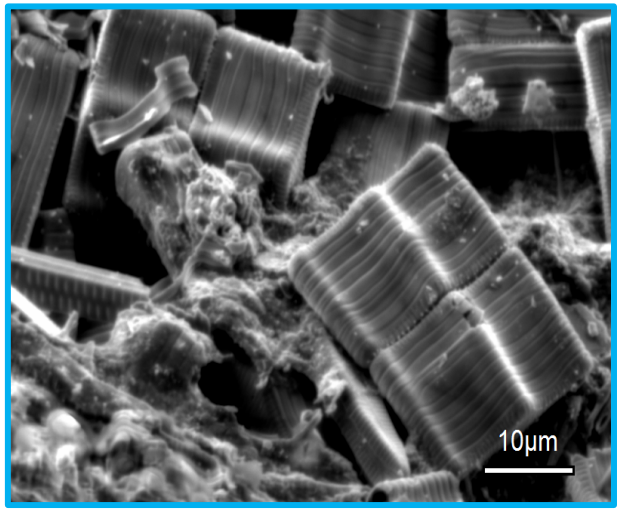


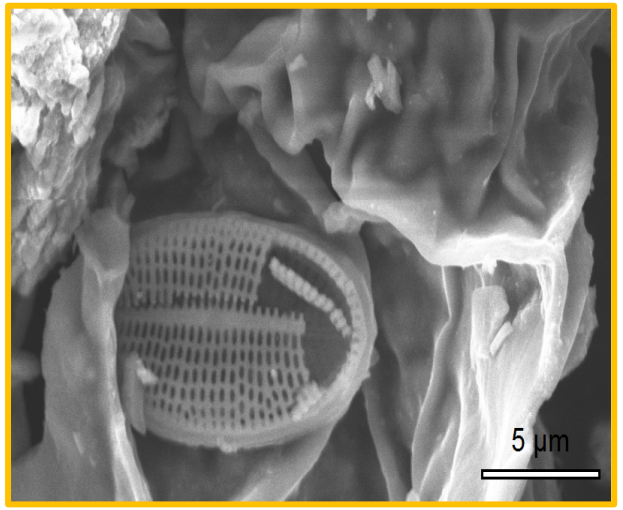
Hornwort and alga characteristics





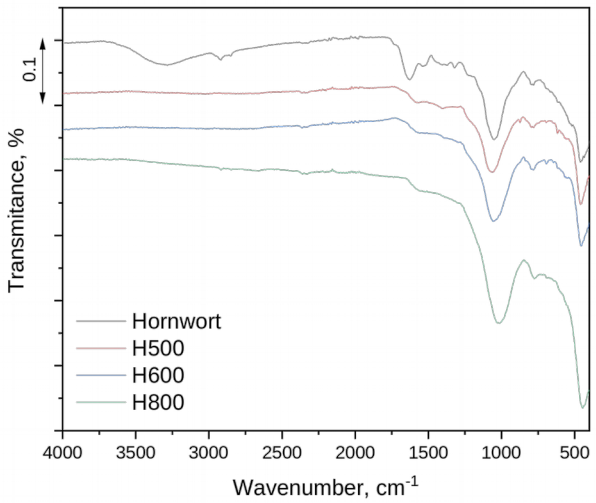
SEM of 800°C bio-chars

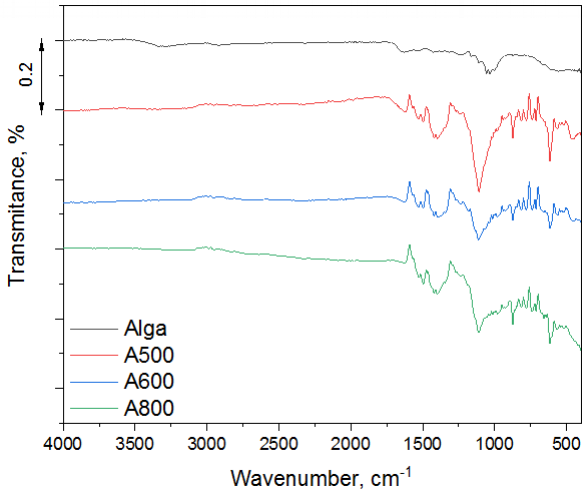




Hornwort and alga characteristics

FTIR



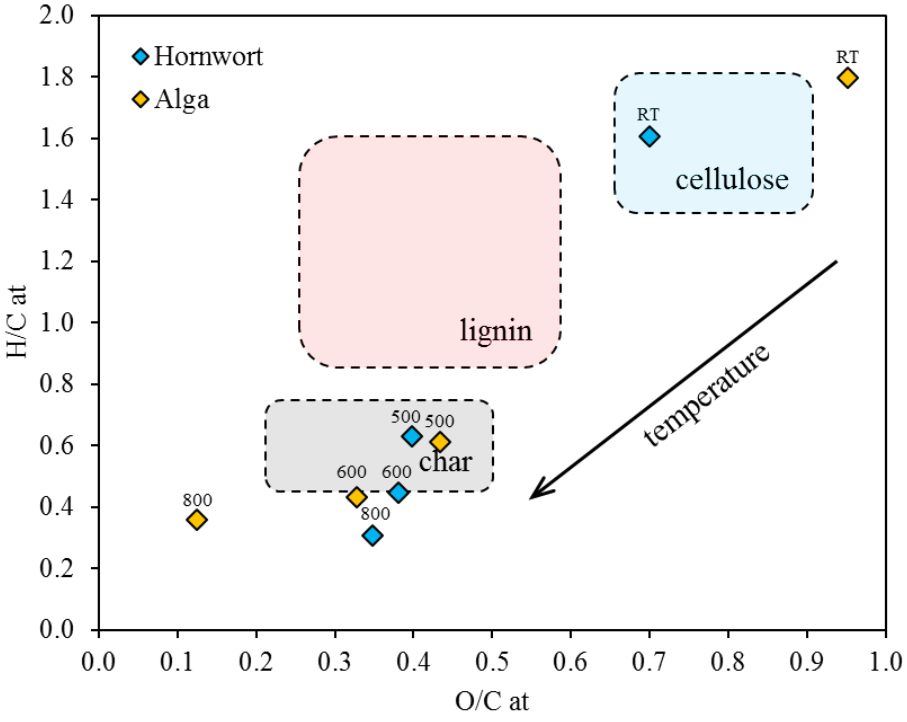


Ultimate analysis

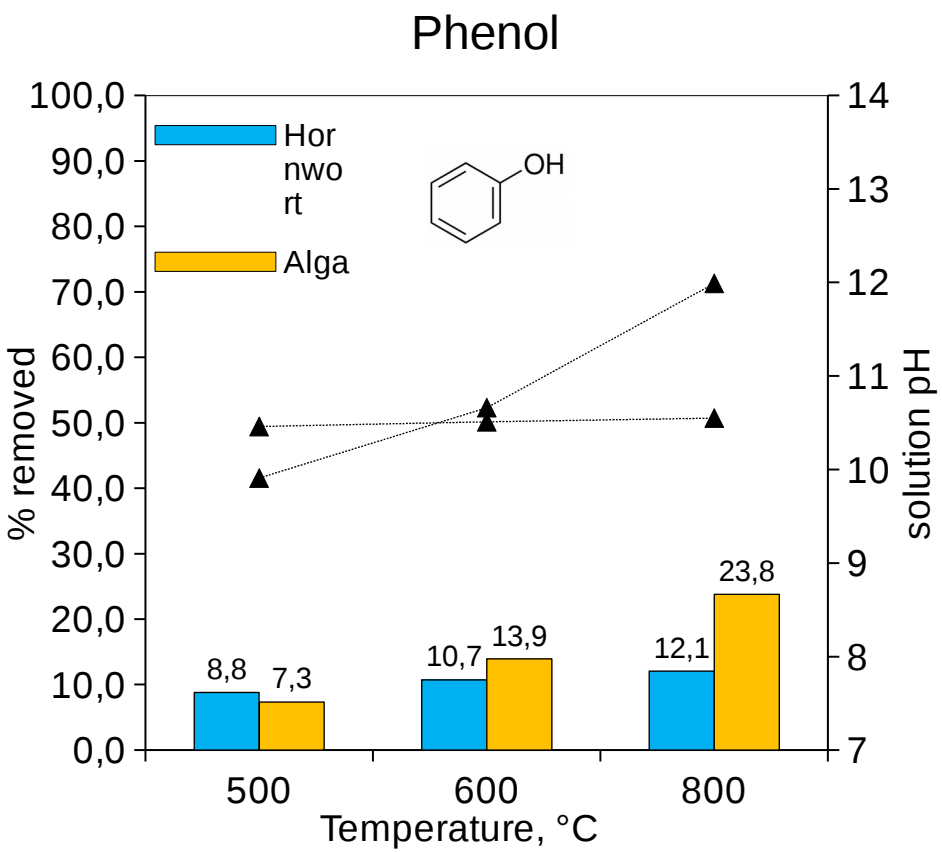
Sample	C^{daf}	H^{daf}	O^{diff}	N^{daf}	S^{d}
	%	%	%	%	%
Hornwort	45.5	6.1	42.5	5.3	0.64
H500	59.0	3.1	31.3	6.0	0.37
H600	60.9	2.3	30.9	5.2	0.42
H800	64.0	1.6	29.7	3.9	0.40
Alga	38.8	5.9	49.3	4.0	1.62
A500	55.2	2.8	31.9	5.0	2.97
A600	60.8	2.2	26.5	4.8	3.08
A800	73.3	2.2	12.2	4.2	3.49

daf - dry ash-free basis, diff – calculated by difference, d – dry basis

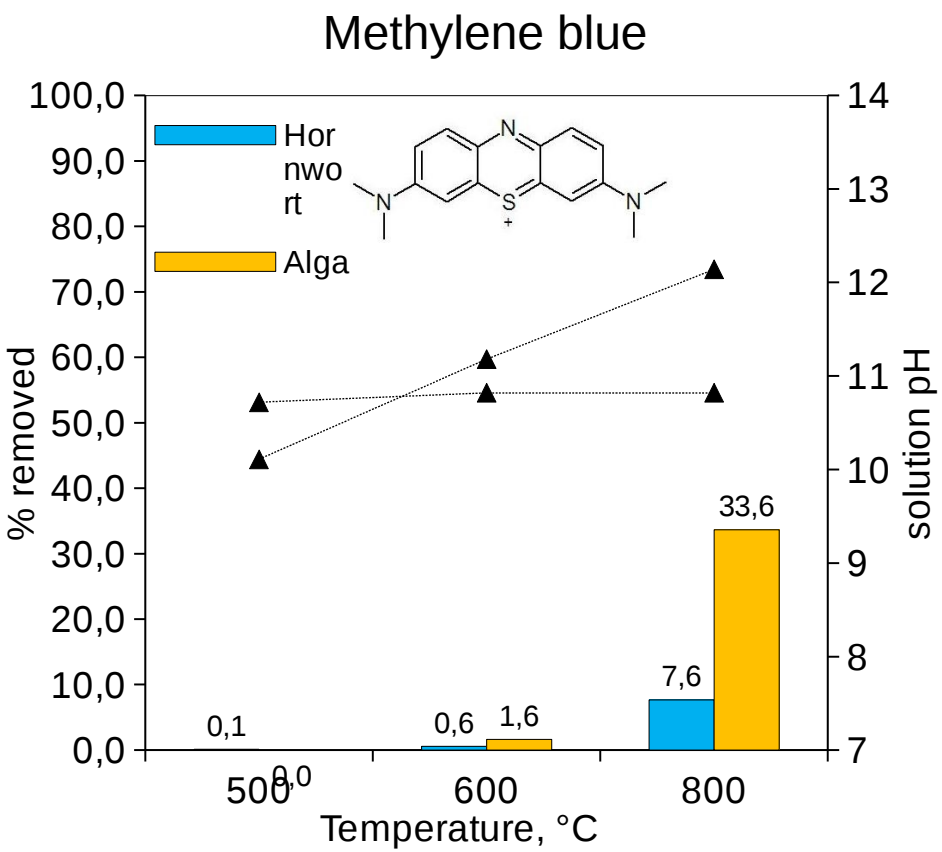
Van Krevelen diagram



„Single point” adsorption of dyes

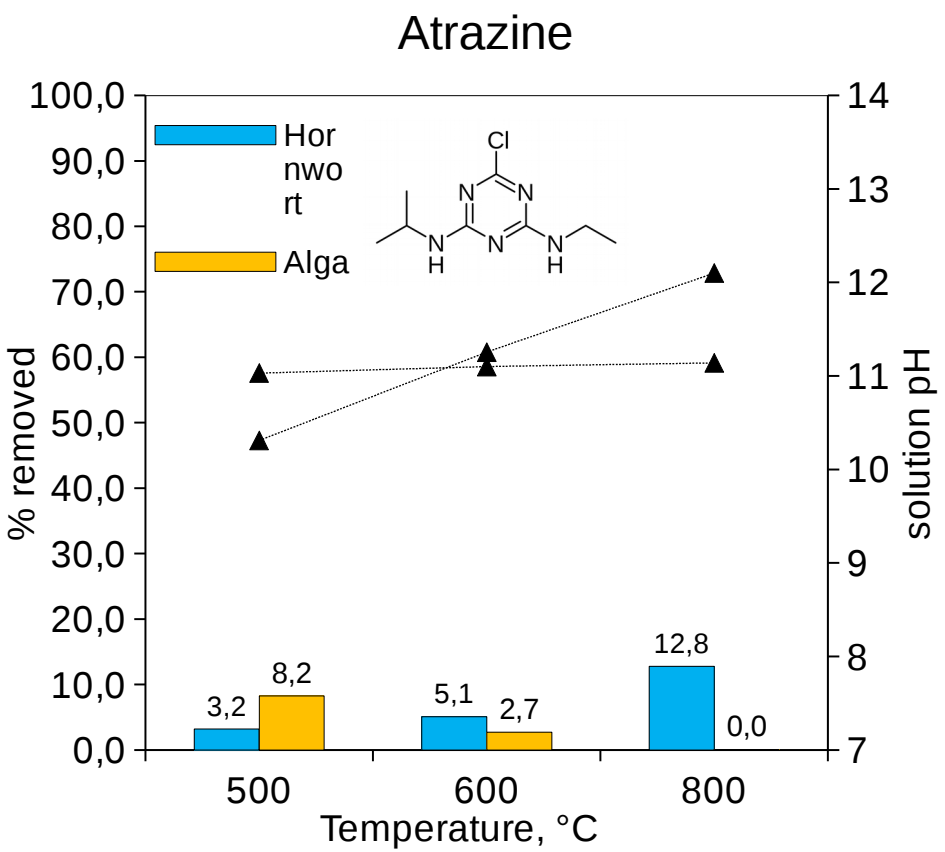


Initial concentration: 100 mg/dm³
Initial solution pH value: 7.73
Mass of bio-char: 0.1 g
Solution volume: 100 cm³
Sorption time: 24 h

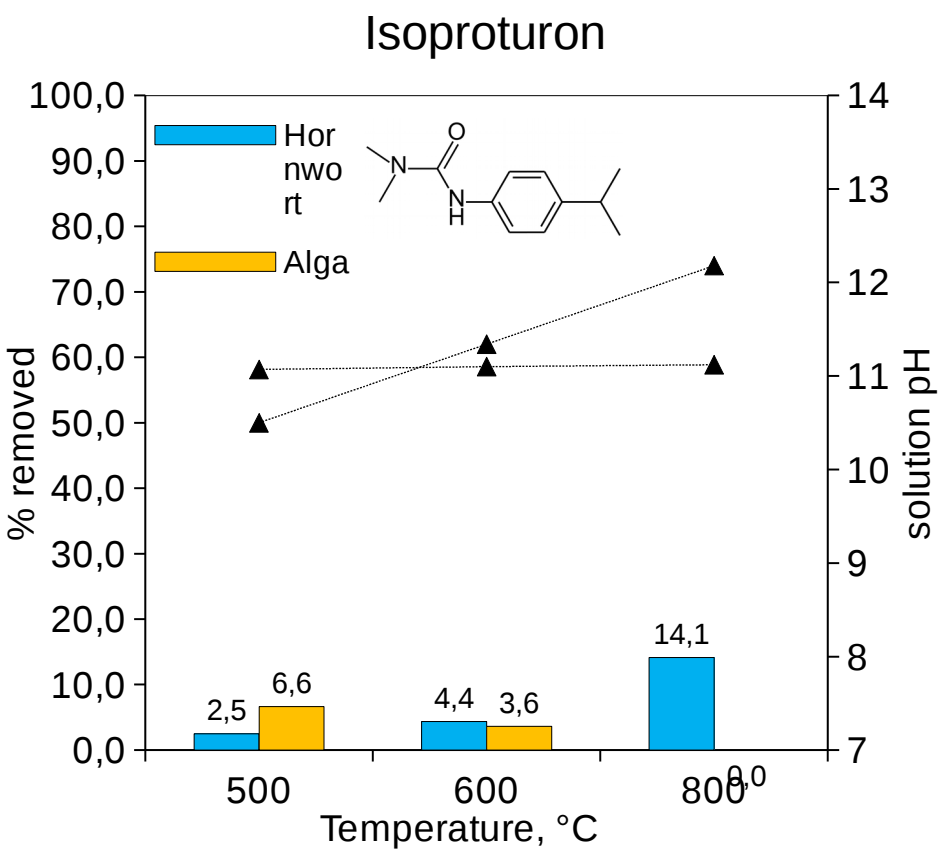


Initial concentration: 50 mg/dm³
Initial solution pH value: 7.77
Mass of bio-char: 0.1 g
Solution volume: 100 cm³
Sorption time: 24 h

„Single point” adsorption of herbicides

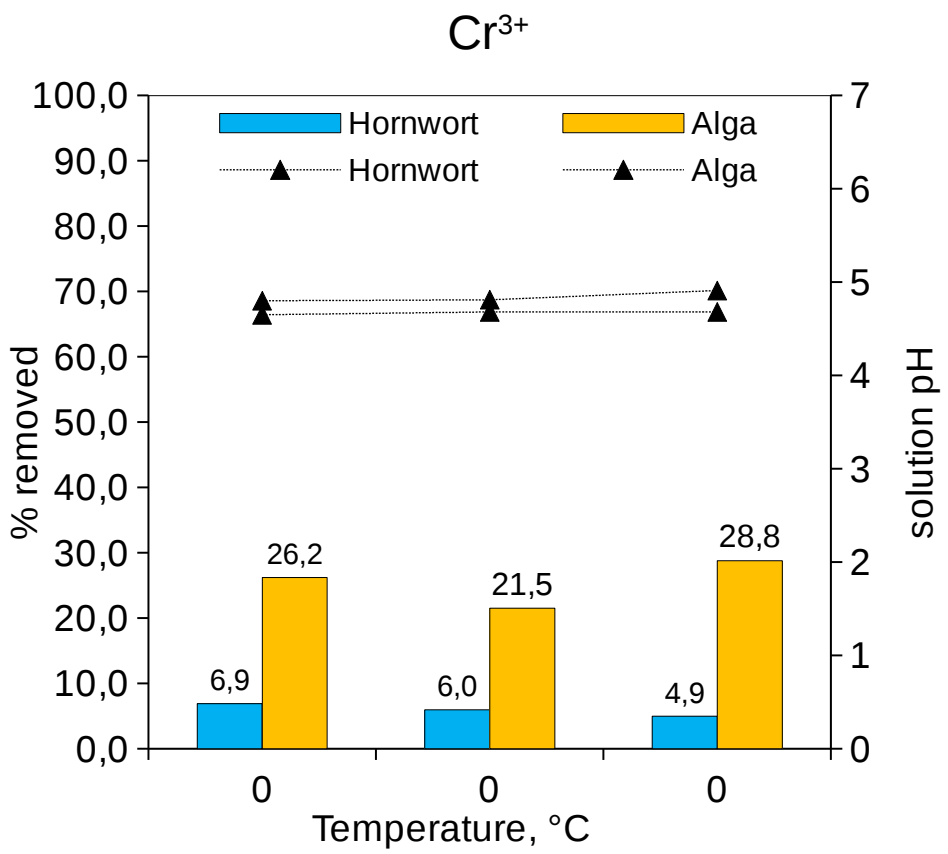


Initial concentration: 10 mg/dm³
Initial solution pH value: 7.70
Mass of bio-char: 0.1 g
Solution volume: 100 cm³
Sorption time: 24 h

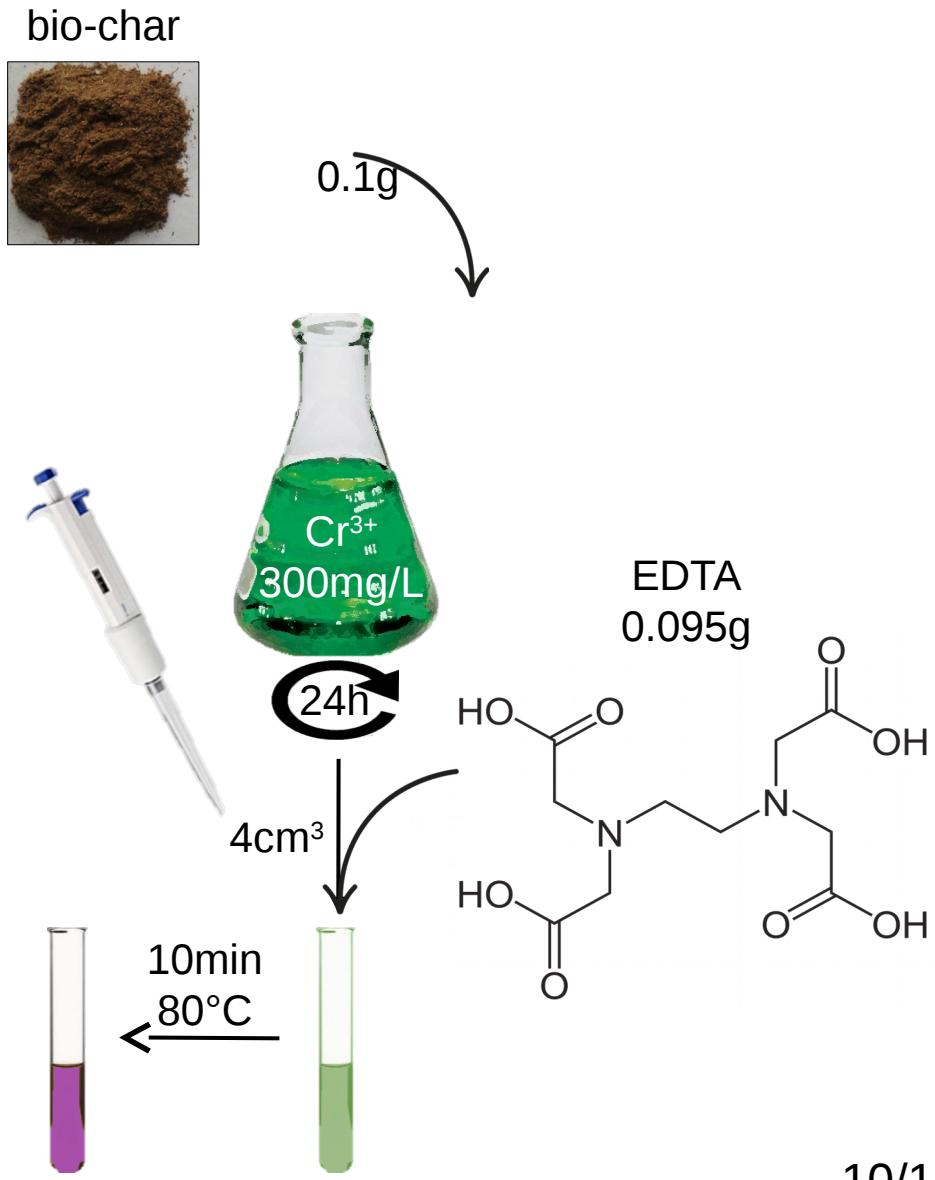


Initial concentration: 10 mg/dm³
Initial solution pH value: 7.68
Mass of bio-char: 0.1 g
Solution volume: 100 cm³
Sorption time: 24 h

„Single point” adsorption of heavy metal



Initial concentration: 300 mg/dm³
Initial solution pH value: 4.61
Mass of bio-char: 0.1 g
Solution volume: 100 cm³
Sorption time: 24 h



Conclusions

- high amounts of ash in bio-chars derived from aquatic biomass (up to 57%), is a result of presence of silica (from diatoms) and alkali metals oxides

- alkali metals oxides presence results in high pHpzc values of obtained bio-chars (up to 13)

- bio-chars were examined in „single point” adsorption of dyes: *i*) phenol and methylene blue, *ii*) herbicides: atrazine, isoproturon, *iii*) heavy metal: Cr^{3+}

- significant coefficient between the pHpzc value and sorption capacity was observed

Thank you for your attention!