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Eucalyptus biochar as a sustainable nanomaterial for electrochemical sensors

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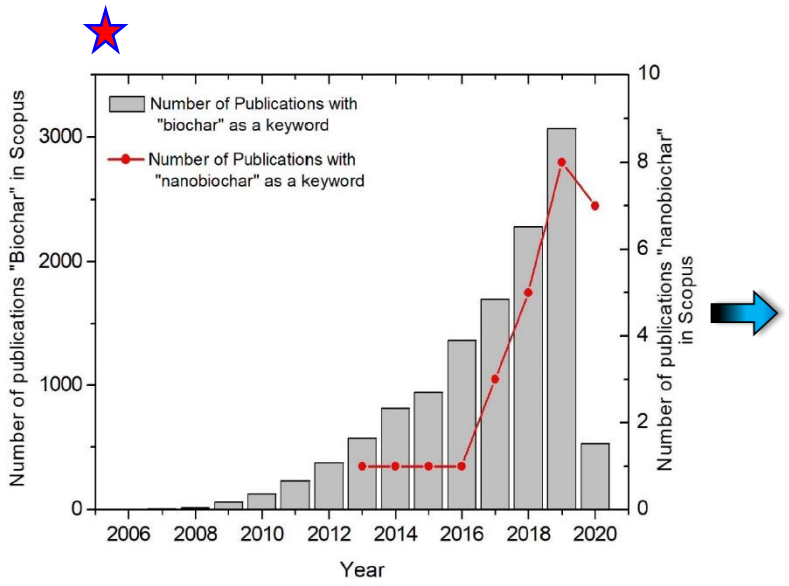
State of the art



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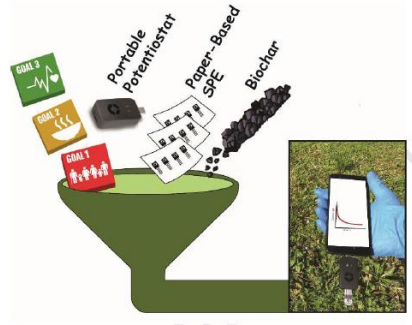
Sustainable materials for the design of forefront printed (bio)sensors applied in agrifood sector

Fabiana Arduini [a, b], Laura Micheli [a], Viviana Scognamiglio [c], Vincenzo Mazzaracchio [a], Danila Moscone [a, *]



Journal of Cleaner Production 255 (2020) 120267
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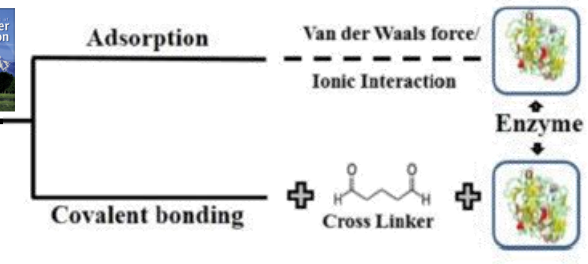
Review

Biochar: Production, properties and emerging role as a support for enzyme immobilization

Deepshikha Pandey*, Achlesh Daverey*, Kusum Arunachalam**



Trends in Environmental Analytical Chemistry 26 (2020) e00089
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Electrochemical devices obtained from biochar: Advances in renewable and environmentally-friendly technologies applied to analytical chemistry

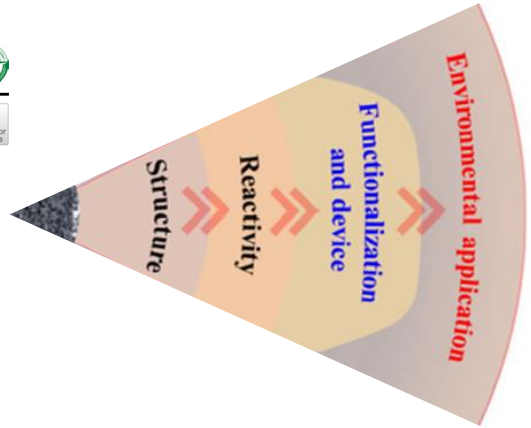
Leandro S. de Almeida, Eliézer Q. Oreste, Juliana V. Maciel, Mônika G. Heinemann, Daiane Dias*

Biochar
https://doi.org/10.1007/s42773-020-00041-7
REVIEW

Application of biochar-based materials in environmental remediation: from multi-level structures to specific devices

Lun Lu[1,2] · Wentao Yu[1,2] · Yaofeng Wang[1,2] · Kun Zhang[1,2] · Xiaomin Zhu[1,2] · Yuecan Zhang[1,2] · Yajing Wu[1,2] · Habib Ullah[1,2] · Xin Xiao[1,2] · Baoliang Chen[1,2]

Received: 1 January 2020 / Accepted: 25 February 2020

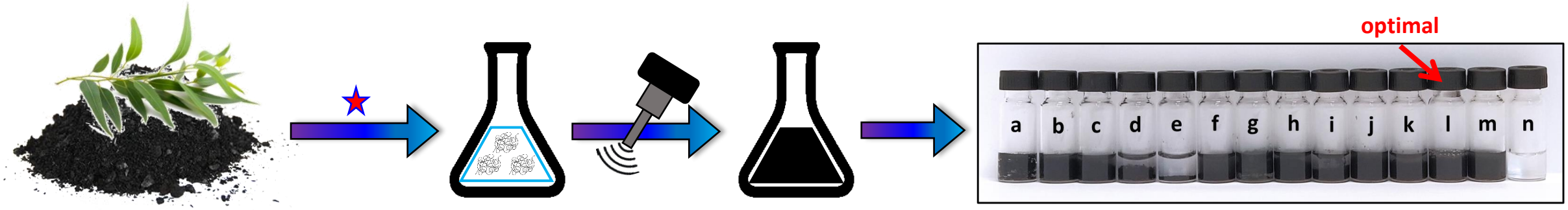


Ramanayaka, S., Vithanage, M., Alessi, D. S., Liu, W. J., Jayasundera, A. C., & Ok, Y. S. (2020). *Environmental Science: Nano*, *7*(11), 3279-3302.

Xiao, X., Chen, B., Chen, Z., Zhu, L., & Schnoor, J. L. (2018). *Environmental science & technology*, *52*(9), 5027-5047.

Biochar preparation, electrode set-up and fabrication

Preparation of Biochar dispersion through liquid-phase sonochemical approach



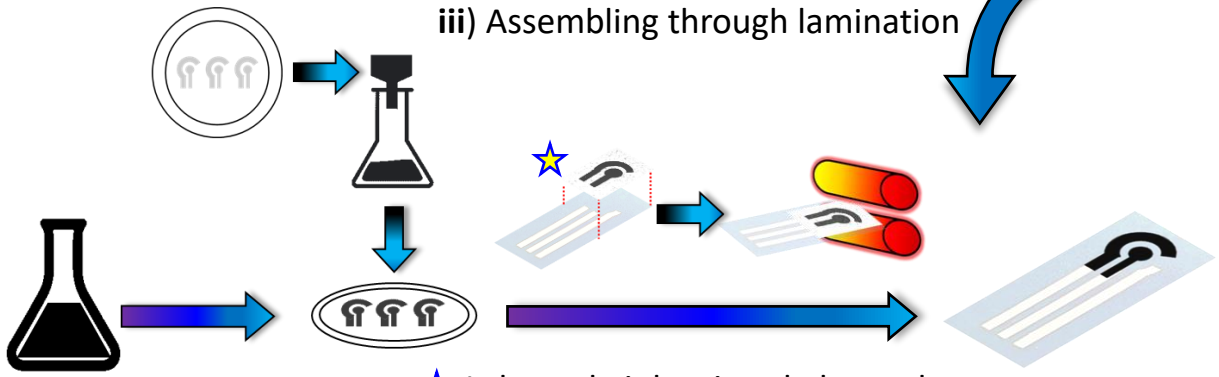
Biochar powder → Biochar fiber → Biochar nanofiber

★ Organic solvents (ethanol, ACN, DMSO, DMF, dichlorethane) and Organic solvent-H_2O (50:50 v/v) (a-k)
Water by using bio-surfactants: sodium cholate (l) and tannic acid (m)

Biochar-based electrode assembling strategies

BH-Film

i) Vacuum filtration
ii) Components alignment
iii) Assembling through lamination



☆ Lab-made ink-printed electrode

BH-SPE

Drop casting

☆ Commercial Screen printed electrode

Biochar as sensing element: amount optimization

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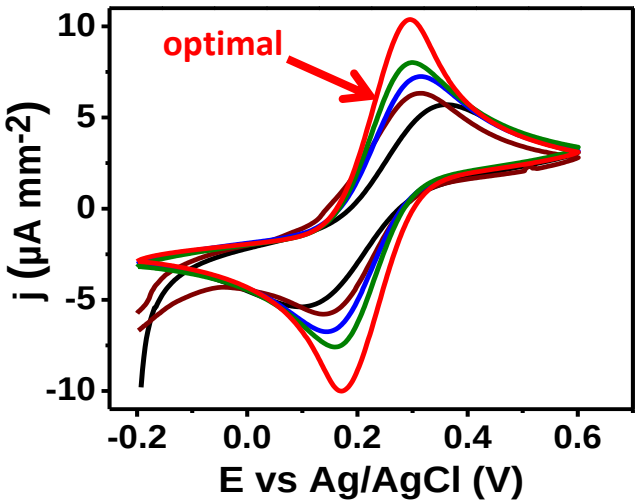
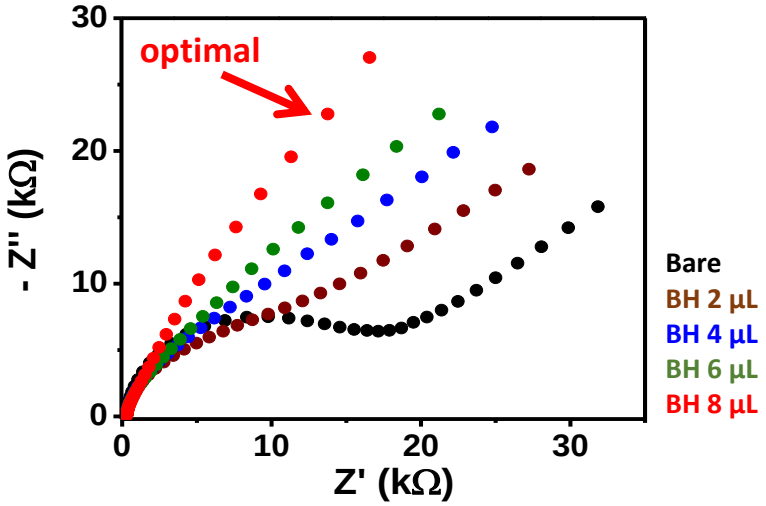
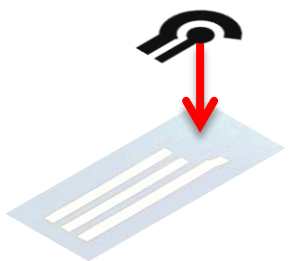
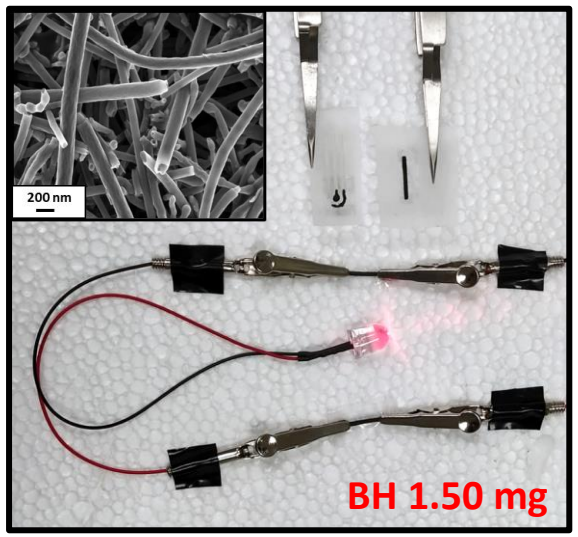
BH-SPE

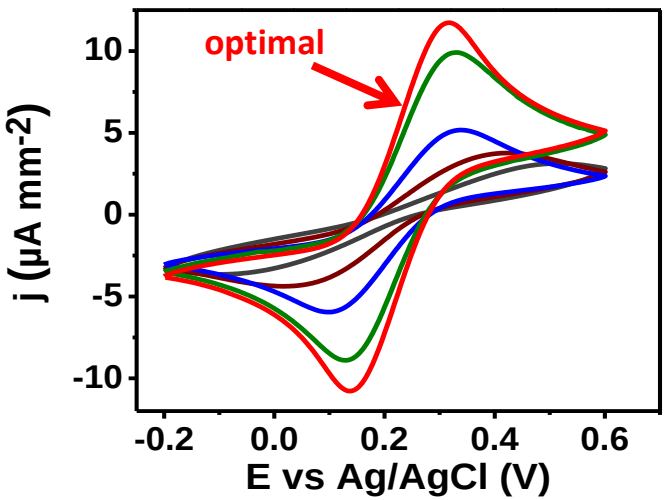


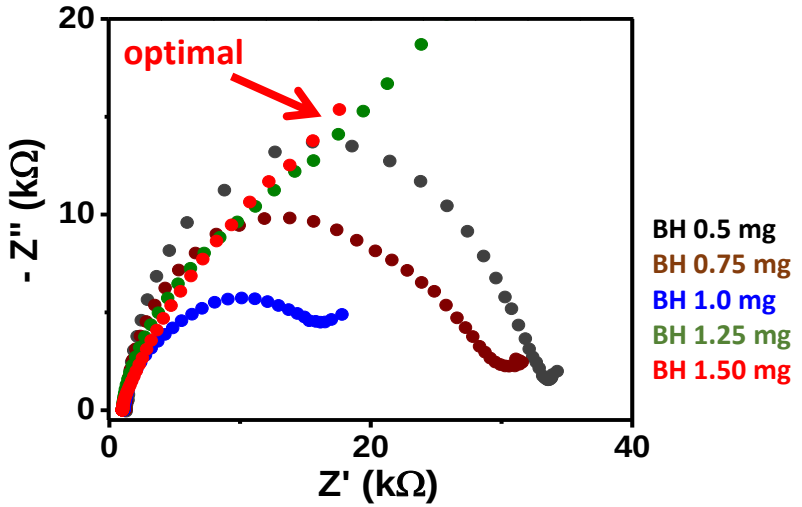


BH-Film







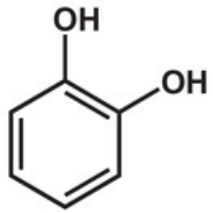


CVs: 5 mM $Fe(CN)_6^{4-/3-}$ in 0.1M KCl; scan rate 25 mV s^{-1} .
EIS: 5 mM $Fe(CN)_6^{4-/3-}$ in 0.1M KCl; frequency range of 10^5 - 10^{-1} Hz using 5mV as sinusoidal wave amplitude, fixing the potential at open circuit.

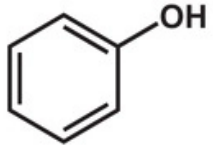
Biochar as sensing element: mono- and ortho-phenols evaluation

Explorative cyclic voltammetries

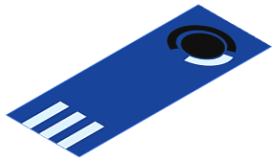
Ortho-phenol



Mono-phenol

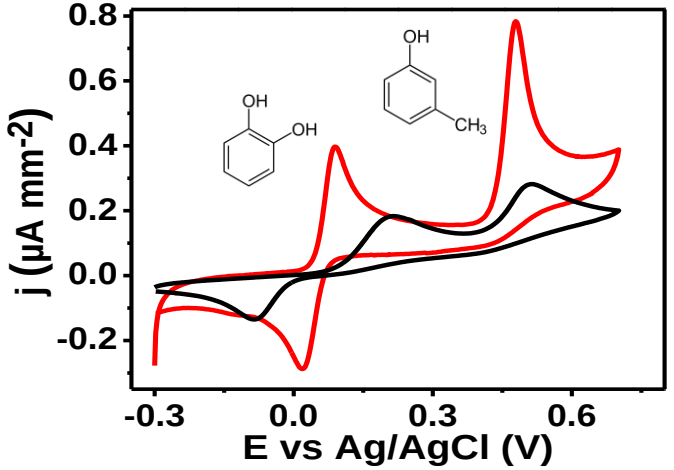


Bare electrode
(black line)

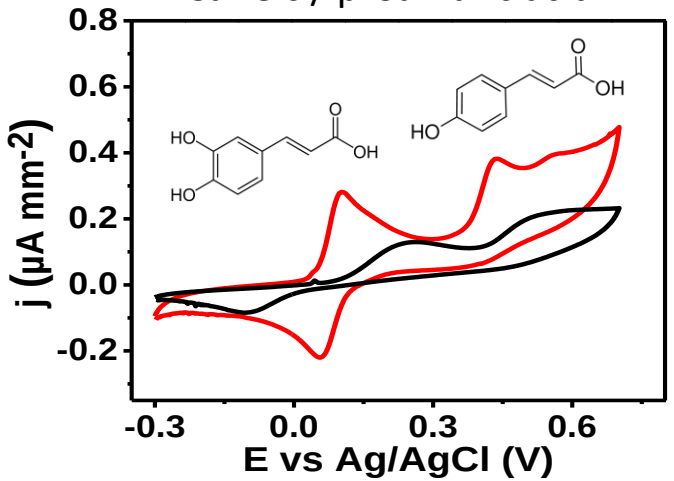


BH-SPE
(red line)

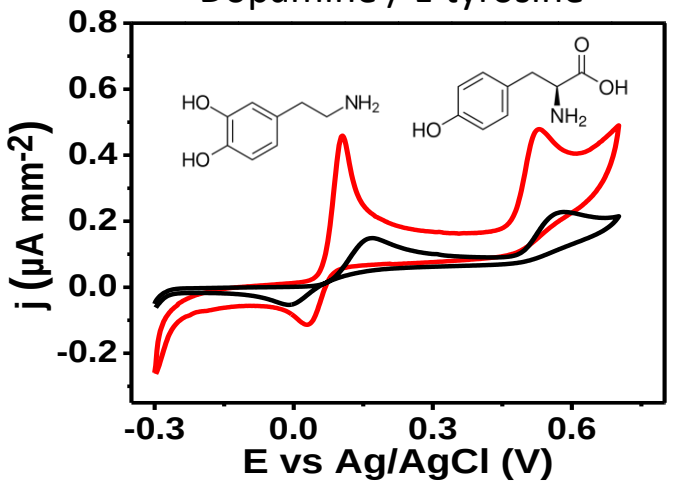
Catechol / m-Cresol



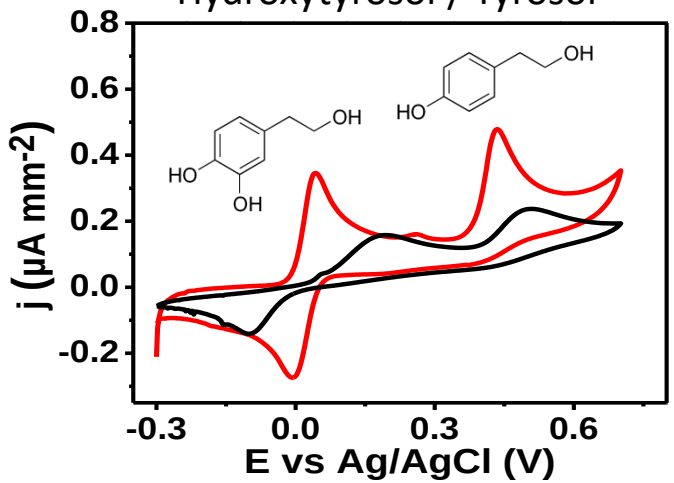
Caffeic / p-Cumaric acid



Dopamine / L-tyrosine



Hydroxytyrosol / Tyrosol



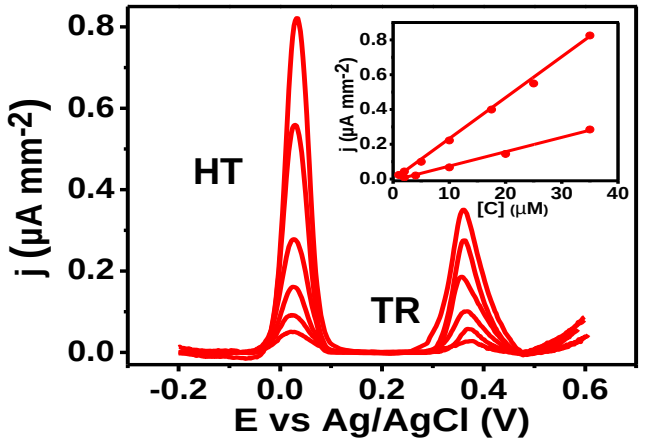
Cyclic voltammograms at 25 mV s-1 of phenol-containing molecule couples

Biochar as sensing element: mono- and ortho-phenols evaluation

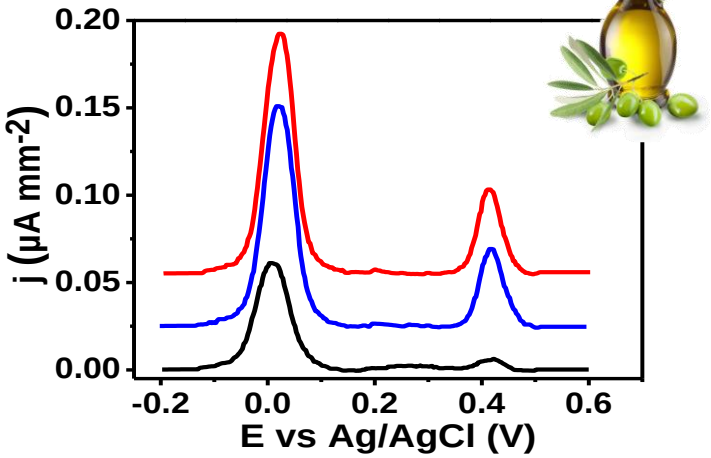
Analysis of Tyrosol and Hydroxytyrosol in extra virgin olive oil

BH-SPE

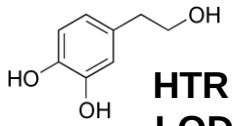
Dose-response curve



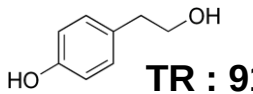
EVOO Sample analysis



Recovery & LOD

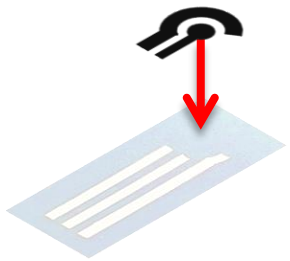


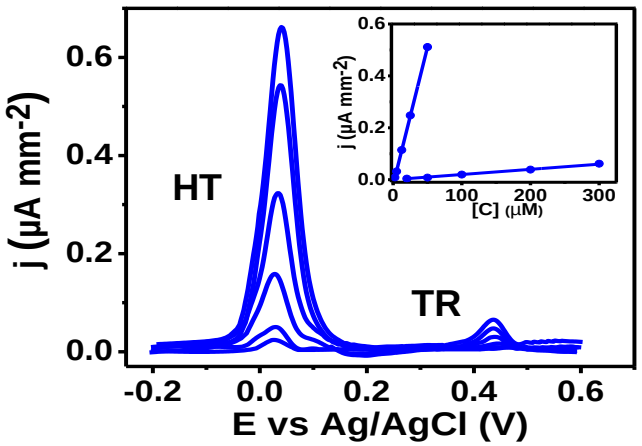
HTR : 97 - 108 %
LOD : 0.5 µM

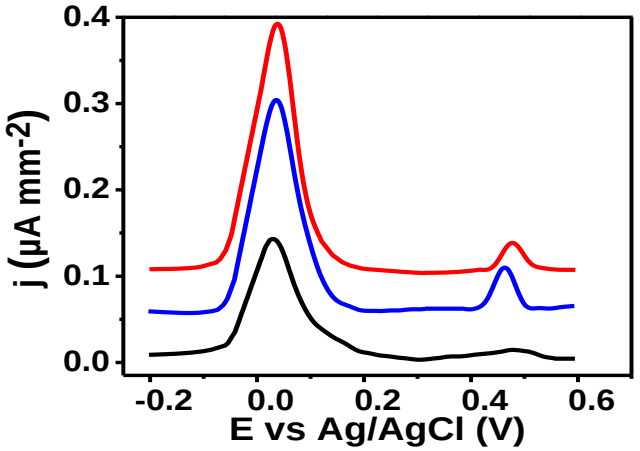


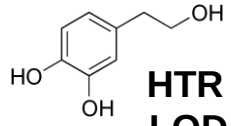
TR : 91 - 111 %
LOD : 3.8 µM

BH-Film

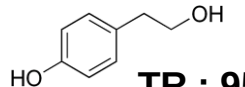








HTR : 96 - 106 %
LOD : 0.2 µM



TR : 95 - 110 %
LOD : 0.6 µM

DPV parameters: Pulse width 50 ms, modulation amplitude 50 mV, scan rate of 25 mV s^{-1}. The samples were diluted 1:200 and 1:100 v/v in PB 0.1 M for BH-SPE and BH-film based electrode respectively.

Conclusions

- A water-soluble Biochar nanofiber dispersion was obtained
- The water-soluble biochar was employed for sensors realization
- The Biochar nanofiber was used as SPE electrode modifier and to realize biochar-based conductive film
- The conductive film was integrated into an entirely lab-made flexible electrode
- The Biochar-based electrodes present great analytical performance for ortho-phenols compounds
- The Biochar-based electrode allow the selective detection of ortho-phenols in presence of mono-phenols compounds
- Sensors showed useful linear ranges and limits of detections
- The sensors were applied in EVOO samples analysis and quantitative recoveries were obtained

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Dr. Daniele Zappi

Dr. Enrico Cozzoni

… THANKs FOR YOUR ATTENTION!