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Reduction in the transfer of persistent organic pollutants from soils to laying hens with biochar and activated carbon amendments

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Context

- Polychlorinated Biphenyls (PCBs), Dioxins, Furans (PCDD/Fs), and Chlordecone (CLD) → Persistent Organic Pollutants (POPs) contaminating soils
- Laying hens → exposed species as they may ingest up to 30 g of soil per day in nonoptimal rearing conditions ⁽¹⁾
- Aim of this study → assess the reduction capacity of 6 different carbonaceous matrices to limit the transfer of POPs to laying hens**

Material and methods

1) Artificial Soil preparation: sand + kaolin + sphagnum peat (OECD, 1984)⁽²⁾

2) Maturation

2 months

3) Treatment (2% by weight)

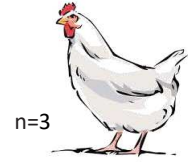
- Control SS (without any matrix)
- 3 Biochars (BCs)
- 3 Activated Carbons (ACs)

4) Maturation

3 months

5) Exposure

20 days

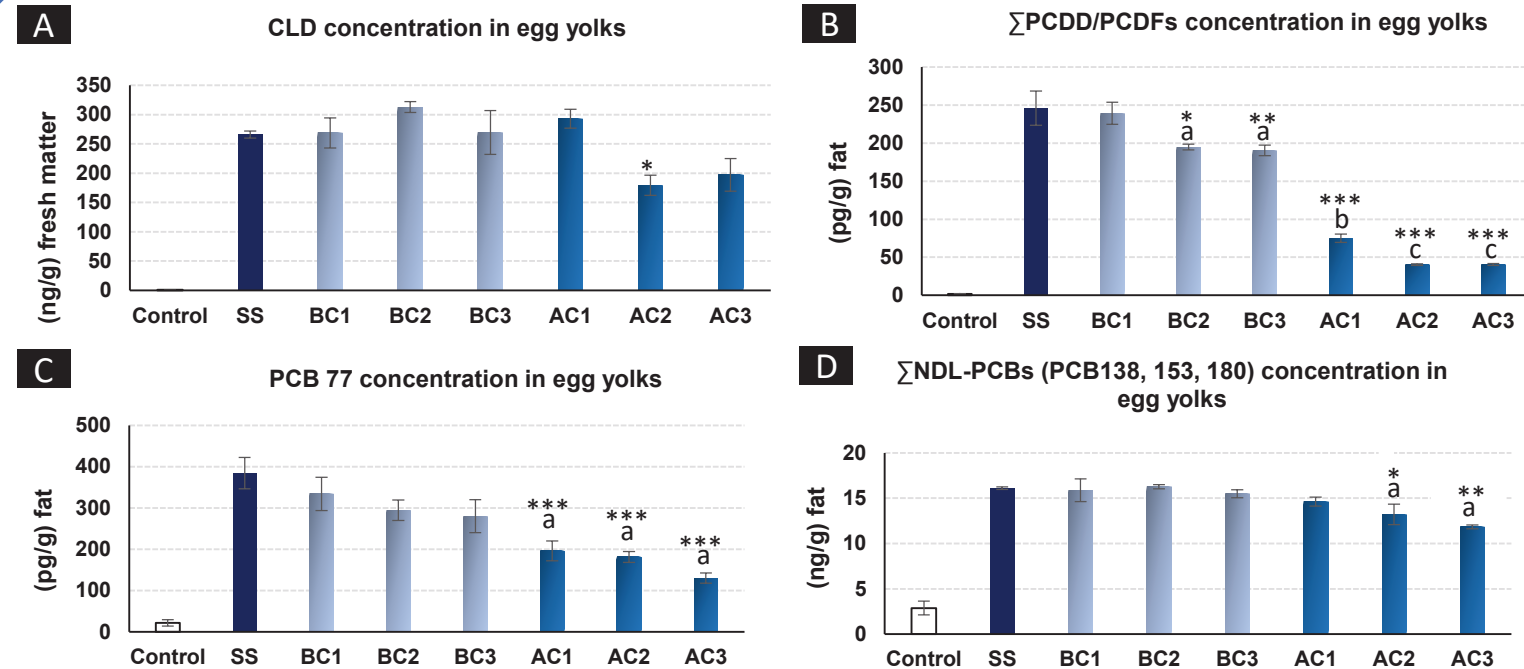


n=3
Oral administration via pellets (80 g of pellets containing 10% of soil/ 2kg of BW/ day)

6) Analysis

- Sampling of egg yolks from D18 to D20
- Quantification by chromatography and mass spectrometry: LC-MS/MS (CLD) and CPG-HRMS (PCBs and PCDD/Fs)
- Determination of pollutants concentrations

Results



Concentrations of CLD, ΣPCDD/Fs, PCB 77 and ΣNDL-PCBs (138, 153, 180) in egg yolks.

Values correspond to the mean ± SE (n=3) concentrations of POPs in egg yolks. Group mean values with superscript asterisks are statistically different from non-amended soil (SS) (*: 0.05>P>0.01; **: 0.01>P>0.001; ***: P< 0.001) using a variance analysis and a Dunnett post-hoc test. Groups mean concentrations with different superscript letter (a, b, c) are statistically different (P<0.05) from each other using a complementary variance analysis followed by a Tukey post-hoc test on previously found significant groups.

Matrix	Origin	Form	BET specific surface area (m ² ·g ⁻¹)	Relative surface between [0-30] Å	Relative surface between n [30-44] Å	Relative surface between n [44-200] Å	Relative surface between n [200-3000] Å
BC 1	Oak	Powder	31 ± 2	0 %	0 %	0 %	100 %
BC 2	Oak	Powder	290 ± 11	12,3 %	85,7 %	0,1 %	1,9 %
BC 3	Knotweed	Powder	196 ± 6	14,9 %	68,2 %	13,8 %	3,1 %
AC 1	Peat	Granular	566 ± 5	13,2 %	47,1 %	35,4 %	4,3 %
AC 2	Peat	Powder	1142 ± 31	17,7 %	32,3 %	48 %	2 %
AC 3	Pine	Powder	776 ± 21	22,8 %	32,6 %	42,5 %	2,2 %

Physico-chemical characterization of ACs and BCs

- No reduction in transfer was obtained with BC 1 due to the absence of micropores and mesopores and the low specific surface area in comparison with the other matrices
- A slight reduction was obtained with BC 2 and BC 3 because of their limited microporous and mesoporous surfaces
- AC 2 and AC 3 were the most efficient in reducing the transfer given their highest specific surface area and highest mesoporous surface, whereas AC 1 was less efficient because of its granular form
- Reductions in transfer were congener-dependent as follows: PCDD/Fs > PCB77 > NDL-PCBs = CLD

Conclusion and perspectives

- This study leads to the following conclusions:
 - Activated carbon soil amendments can highly reduce the bioavailability of soil organic contaminants to laying hens especially for PCDD/Fs and PCB77
 - The contaminant reduction depends on both, the nature of pollutant and the characteristics of the matrix

- Amendment of contaminated zones by activated carbons could be subsequently applied on small areas

References

- (1) Jondreville, C., Travel, A., Besnard, J., Feidt, C., 2010. Intake of herbage and soil by free-range laying hens offered a complete diet compared to a whole-wheat diet. XIIIth European Poultry Conference, Tours, France, 23-27 August.
- (2) OECD, 1984. Test N° 207 Earthworm Acute Toxicity Test. In Section 4: Effects on Biotic Systems, Vol. 4. Guideline for Testing of Chemicals 207. Paris: OECD Publishing.