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

Nadine El Wanny, Matthieu Delannoy, Moemen Baroudi, Thierry Woignier, Agnès Fournier, Cyril Feidt

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

[1,2]El Wanny N, [1]Delannoy M, [2]Baroudi M, [3]Woignier T, [1]Fournier A, [1]Feidt C

[1]Université de Lorraine-INRA (USC340), URAFPA, 54500 Vandoeuvre-lès-Nancy ; [2] Université Libanaise, Tripoli, Liban ; [3] **Aix Marseille Université,** IMBE, UMR CNRS 7263, Marseille

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)

Uncontaminated soil
Contaminated 6 NDL-PCBs (50,6 µg/Kg MS) + PCB 77 (2,5 µg/Kg MS) + 11 PCDD/Fs (1399 ng/kg MS)
Contaminated CLD (1000 µg/Kg MS)

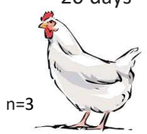
Control SS (without any matrix)
3 Biochars (BCs)
3 Activated Carbons (ACs)

4) Maturation

3 months

5) Exposure

20 days

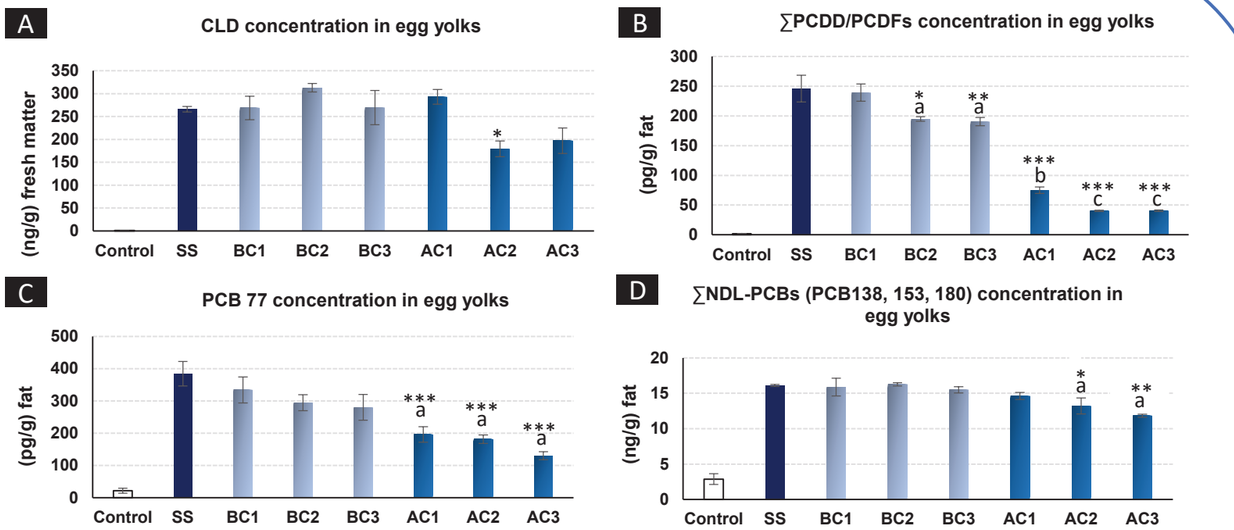


Oral administration via pellets (80 g of pellets containing 10% of soil/ 2kg of BW/ day)

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, ∑PCDD/Fs, PCB 77 and ∑NDL-PCBs (138, 153, 180) in egg yolks.
Values correspond to the mean ± SE (n=3) concentrations of POPs in egg yolks. Group m*ean 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 m*ean 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 ($m^2 \cdot g^{-1}$)	Relative surface between [0-30] Å	Relative surface between [30-44] Å	Relative surface between [44-200] Å	Relative surface between [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	Knotwed	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:

i) Activated carbon soil amendments can highly reduce the bioavailability of soil organic contaminants to laying hens especially for PCDD/Fs and PCB77

ii) 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

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(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.

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