Ecole Doctorale SIReNa - Sciences et Ingénierie des Ressources Naturelles

Annual seminar SIReNa 2020 - **The thesis seen from another angle**

(La thèse vue sous un autre angle)

Oral (3 minutes «vulgarisation and 9 minutes «science») ☐

Poster ☒

Présentation « flash » poster (2 diapositives) ☐

Title:

Assessment of bioavailability and bioaccessibility of persistent organic pollutants in the chain «soil-animal-food»

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Abstract (1/2 page max)

Environmental contaminants (metals, POPs) can be stored during centuries in soil, therefore soil is a major exposure matrix. All free ranged (food producing) animals ingest soil at different levels. Soil is one of the main vector for contaminants in animals and then in food.

Objective of Research: Reducing the transfer of POPs in the food chain "soil – farm animals – food products of animal origin“using different sequestration materials.

To achieve this objective several aims, and tasks were fixed:

Aim 1	**Aim 2**	**Aim 3**
Evaluation of POP transfer to food of animal origin	Characterization POPs mobility in soil.	Reducing the POP transfer from soil to animals by application of sequestration materials.
↓	↓	↓
Task 1 – Literature review (meta-analysis)	Task 2 – *In vitro* assessment of POPs availability in soils	Task 3 – *In vitro* assessment of the efficiency of POP sequestration Task 4 – *In vivo* validation of Sequestration strategies

Estimation of POP transfer to food of animal origin will be performed using 3 main scientific concepts.

Environmental availability corresponds to the fraction of contaminants released from soil which become potentially available in the environment. Assessment of the environmental availability will be performed in vitro using soil samples spiked by different POPs (Aim №2). Soil will be added to aqueous solution containing Tenax, a nanoporous sorbent which will be adsorbed released POPs from soil to water. Tenax will be extracted and analyzed by gas chromatography mass-spectrometric detection (GC-MS) to estimate levels of POP liberated from soil and absorbed by Tenax. In this case Tenax absorption quantifies the environmental availability of the soil-bound POPs.

Involuntary animal ingestion of soil especially contaminated with POPs lead to the fact that these contaminants become available for absorption in gastrointestinal tract and bloodstream. The fraction of contaminants that transfers from environment matrix as soil and absorbed by digestive system refers to the concept of ***bioaccessibility***. The aim №3 of the PhD is reducing the absorption of POPs from soil to animals by application of sequestration materials. These works will be divided into two tasks:

-Assessment of sequestration in vitro. Activated carbon matrices will be added to contaminated soil. It is expected that POPs will be adsorbed and sequestrated by these séquestrants leading to a reduction of their availability for animal uptake.

-In vivo validation of sequestration strategies. To validate sequestration strategies *in vivo* contaminated soil with activated carbon will be mixed and given to experimental animals as dough balls. Animals will be orally exposed to non-toxic dose of target contaminants. Adipose and muscle tissues as well as milk will be extracted and analyzed by GC/MS to estimate transfer levels of POPs in animal body and the subsequent animal food products.

Keywords. Environmental availability, bioaccessibility, persistent organic pollutants, soil, food of animal origin.

Assessment of bioavailability and bioaccessibility of persistent organic pollutants in the chain «soil-animal-food»

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CONTEXT

- Environmental contaminants (metals, POPs) can be stored during centuries in soil, therefore soil is a major exposure matrix
- All free ranged (food producing) animals ingest soil[1;2] at different levels
- Soil is one of the main vector for contaminants in animals and then in food

OBJECTIVE

Reducing the bioavailability of POPs in the food chain "soil – farm animals – food products of animal origin“ using different sequestration materials.

AIM № 1

Evaluation of POP transfer to food of animal origin

Task 1

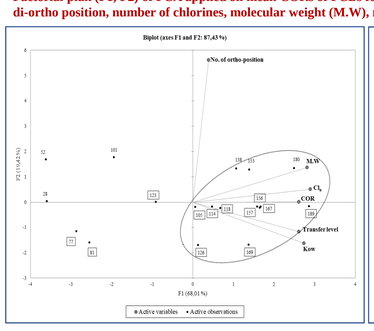
Literature review (meta-analysis)

Preliminary results.

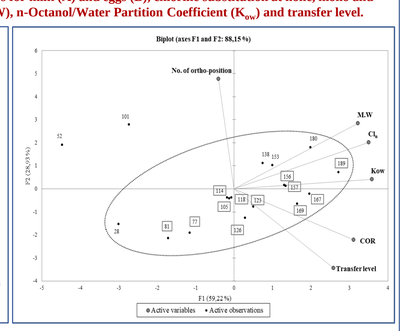
Mean and SDs of carry-over rates (COR) of PCDD/Fs in milk and eggs derived from the literature

Cl_n	Compound	Transfer to milk		Transfer to eggs	
		COR, %	Transfer level	COR, %	Transfer level
4	2,3,7,8-TCDD	**34.5** ±14.3	**high**	**40.5** ± 0.7	**high**
5	1,2,3,7,8 -PeCDD	**36.0** ± 12.4	**high**	**44.5**± 4.9	**high**
6	1,2,3,4,7,8-HxCDD	**26.8** ± 8.9	**high**	**43.0** ± 1.4	**high**
6	1,2,3,6,7,8-HxCDD	**28.1** ± 13.7	**high**	**44.0** ±0	**high**
6	1,2,3,7,8,9-HxCDD	17.8 ± 6.5	medium	**33.0** ± 1.4	**high**
7	1,2,3,4,6,7,8-HpCDD	5.06 ± 3.3	low	21.5 ± 0.7	medium
8	OCDD	0.72 ± 0.6	low	10.5 ± 3.5	low
4	2,3,7,8-TCDF	2.41 ± 2.70	low	**40.0**±0	**high**
5	1,2,3,7,8-PeCDF	4.45 ± 4.00	low	**43.5** ± 6.4	**high**
5	2,3,4,7,8-PeCDF	**40.6** ± 18.2	**high**	**41.0** ± 4.2	**high**
6	1,2,3,4,7,8-HxCDF	**26.2** ± 11.3	**high**	**43.5** ± 0.7	**high**
6	1,2,3,6,7,8-HxCDF	**25.6** ± 11.6	**high**	**41.0** ± 1.4	**high**
6	1,2,3,7,8,9-HxCDF	14.3 ± 6.10	medium	**33.0** ± 2.8	**high**
6	2,3,4,6,7,8-HxCDF	19.0 ± 16.9	medium	**40.0** ± 1.4	**high**
7	1,2,3,4,6,7,8-HpCDF	4.63 ± 3.20	low	18.0 ± 0	medium
7	1,2,3,4,7,8,9-HpCDF	5.87 ± 4.10	low	20.5 ± 0.7	medium
8	OCDF	0.54 ± 0.60	low	6.00 ± 1.4	low

Factorial plan (F1, F2) of PCA applied on mean CORs of PCBs for milk (A) and eggs (B), chlorine substitution at none, mono and di-ortho position, number of chlorines, molecular weight (M.W), n-Octanol/Water Partition Coefficient (K_{ow}) and transfer level.



Milk



Chicken eggs

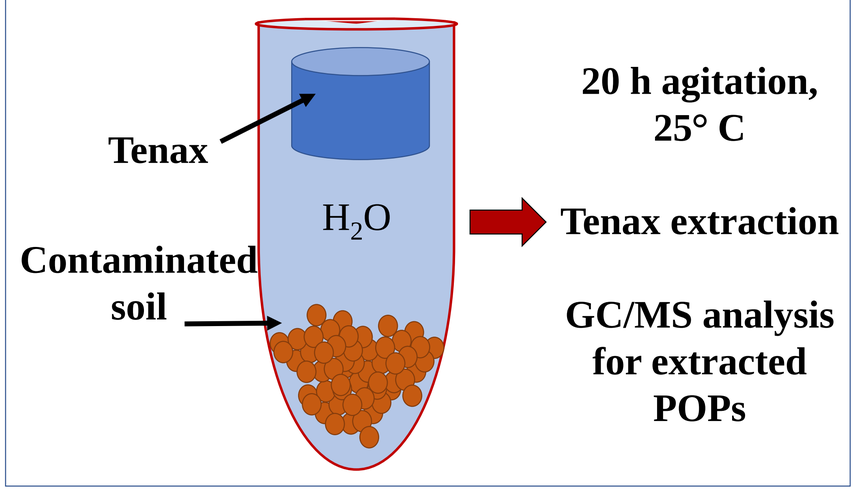
Indication: Numbers correspond to the PCB isomers. Framed congeners are dioxin-like PCBs. Circle with PCBs are the high excreted congeners with the range 37.5-83.5% and 40.5-80.0% for milk and eggs respectively.

AIM № 2

Characterization of POP mobility in soil

Task 2

***In vitro* assessment of POPs availability in soils**

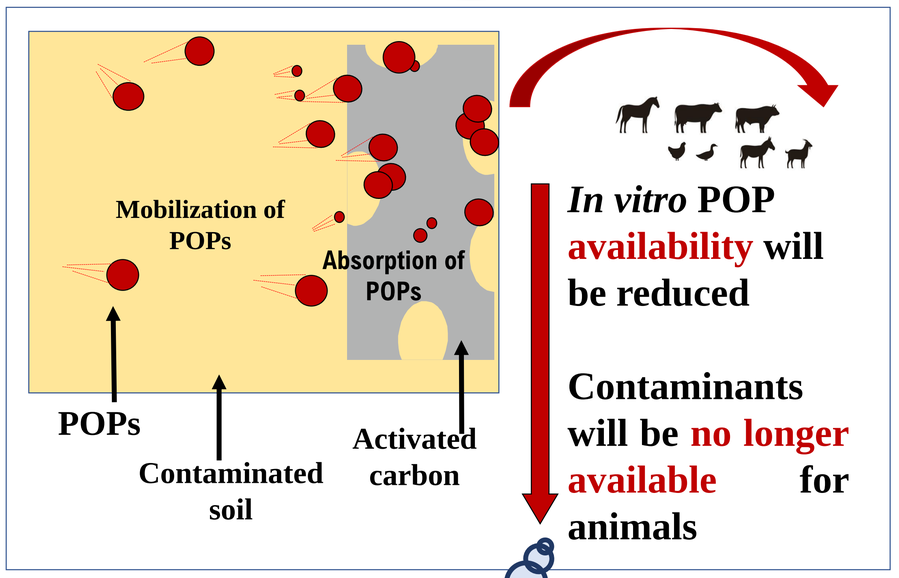


AIM № 3

Reducing the POP transfer from soil to animals by application of sequestration materials

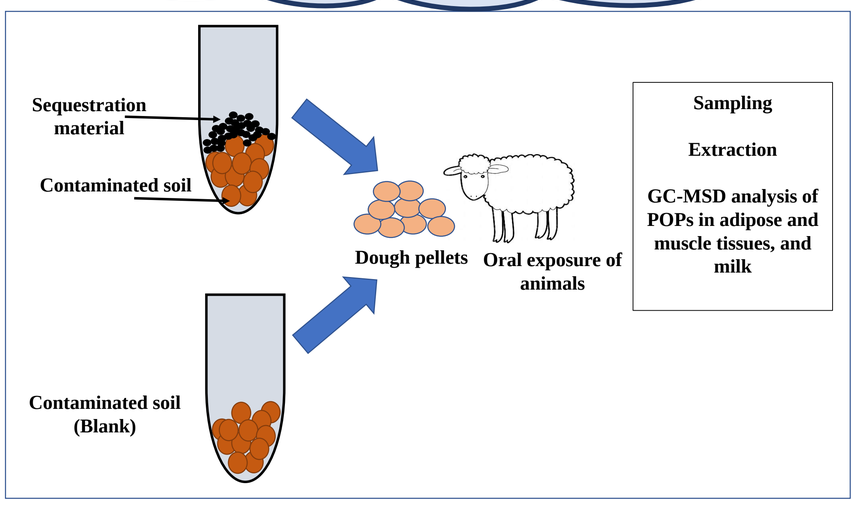
Task 3

***In vitro* assessment of the efficiency of POP sequestration**



Task 4

***In vivo* validation of Sequestration strategies**



SCIENTIFIC PRODUCTIONS (2018-2021)

№	Topics of scientific publication	Type of publication	Status	Year	Journal
1	Transfer of persistent organic pollutants in camel milk	Communication/ poster	published	Aug., 2019	70th Annual Meeting of the European Federation of Animal Science, Ghent (Belgium), 26 - 30 Aug 2019
2	Evaluation of two contrasted activated carbon based sequestration strategies to reduce soil bound chlordecone bioavailability in piglets	Article	published	Dec., 2019	Environmental Science and Pollution Research **(IF - 2.8)**, In press, doi: 10.1007/s11356-019-06494-z
3	Transfer of persistent organic pollutants in food producing animals (meta-analysis)	Article	In process	2020	Chemosphere (IF=4.4)
4	Assessment of PCDD/Fs and PCBs transfer to milk and eggs	Communication/oral report	In process	2020	DIOXIN 2020, the 40th International Symposium on Halogenated Persistent Organic Pollutants (POPs) from 30 August to 4 September 2020.
Additional articles that were recently published not in the topic of PhD:					
5	Volatile organic compounds profiles in milk fermented by lactic bacteria.	Article	published	Jan., 2018	International Journal of Biology and Chemistry 11, № 2, 57, doi.org/10.26577/ijbch-2018-2-345
6	Comparative study of fatty acid and sterol profiles for the investigation of potential milk fat adulteration.	Article	published	Sept., 2019	Journal of Dairy Science. Volume 102, Issue 9,, p. 7723-7733, doi.org/10.3168/jds.2018-15620. **(IF = 3.08)**

1.Jurjanz, S., Germain, K., Juin, H., Jondreville, C. Plant and soil intake by organic broilers reared in tree- or grass-covered plots as determined by means of n-alkanes and of acid-insoluble ash. **2015**, ANIMAL, 9 (5), pp. 888-898.
2.Jurjanz, S., Collas, C., Lastel, M.-L., Godard, X., Archimède, H., Rychen, G., Mahieu, M., Feidt, C. Evaluation of soil intake by growing Creole young bulls in common grazing systems in humid tropical conditions. **2017**, *Animal, 11 (8), pp. 1363-1371.*