Undernutrition combined with dietary mineral oil: a nutritional strategy enhancing removal of dioxins and polychlorinated biphenyls in contaminated ewes

Sylvain Lerch[1], Lucille Rey-Cadilhac[1,2], Ronan Cariou[3], Catherine Jondreville[1], Yannick Faulconnier[2], Denis Roux[4], Gaud Dervilly-Pinel[3], Bruno Le Bizec[3], Stefan Jurjanz[1], Anne Ferlay[1]

[1]*Université de Lorraine / INRA, Vandoeuvre-lès-Nancy, Lorraine, France,* [2]*INRA / Université Clermont Auvergne / VetAgro Sup, Saint-Genès-Champanelle, Auvergne, France,* [3]*LUNAM Université / INRA, Nantes, Pays de la Loire, France,* [4]*INRA, Laqueuille, Auvergne, France*

E-mail: sylvain.lerch@univ-lorraine.fr

Take home message Undernutrition combined with dietary mineral oil hastens the removal of dioxins and polychlorinated biphenyls in ewes' empty body by increasing their faecal excretions by 2.0 to 2.5-fold, when compared to a control treatment.

Introduction Last decades, livestock production has faced several sanitary crises involving contamination of products by persistent organic pollutants (POP, Lake *et al.,* 2005). In order to avoid the disposal of products originating from contaminated herds, strategies hastening POP removal should be implemented. This study aimed at assessing the efficiency of undernutrition (release of lipophilic POP from adipose tissue to blood, Lerch *et al.,* 2016) combined with dietary non-absorbable lipid supplementation (enhancement of POP transfer from blood to faeces by passive diffusion across the intestinal tract wall, Rozman *et al.,* 1984) as a nutritional strategy to hasten dioxins (TCDD) and polychlorinated biphenyls (PCB) removal in contaminated ewes.

Material & methods The experiment was divided into three consecutive periods: i) a 27-day exposure period during which nine non-lactating ewes were daily orally exposed to POP through a spiked concentrate [280±35 pg TCDD, 285±35 pg PCB 126 and 281±35 pg PCB 153 / kg body weight / day]; ii) a 8-day buffering period with a non-spiked diet; and iii) a 58-day depletion period according to two treatments: control well-fed (96% of maintenance energy requirement (MER), CTL, $n = 4$) or underfed (37% of MER) and supplemented with mineral oil (10% of dry matter intake, Codex 68, IGOL, Amiens, France, UFMO, $n = 5$). Faeces were individually pooled over the depletion period. At the end of the depletion period, ewes were slaughtered by stunning followed by exsanguination, before empty body (whole body minus gut contents and wool) was weighed, minced, mixed and homogenized using an industrial mixer-grinder. Total lipids, TCDD and PCB concentrations were determined in faeces and empty body. Faecal flows of POP were estimated by means of acid-insoluble ash analysed in both feedstuffs and faeces. Data were analysed using the MIXED procedure of SAS (2003, Cary, USA) with a model including the depletion treatment (CTL or UFMO) as a fixed effect and the ewe as a random effect.

Results & discussion Faecal POP concentrations (DM basis) in UFMO ewes were 2.1 to 2.5-fold higher than in CTL ewes ($p < 0.01$). In accordance with our results, supplementing a well-fed diet with mineral oil enhanced mirex (a lipophilic organochlorine pesticide listed as POP) faecal concentration by 2-fold in dairy goats (Rozman *et al.,* 1984). Thus, decreases in empty body POP burdens after depletion period were 2 to 3-fold higher in UFMO than in CTL ewes, but these decreases in UFMO ewes accounted for only 7%, 2% and 6% of initial burdens of TCDD, PCB 126 and 153, respectively (Table 1). Concomitantly, estimated elimination half-lives of TCDD were reduced from 1,200 in CTL to 523 days in UFMO ewes. We suspect that the rate of POP transfer from blood to intestine lumen was the limiting step of faecal excretion enhancement due to UFMO. Indeed, the high lipophilicity of some POP (logarithm of octanol/water partition coefficient, log $K_{ow} > 6.8$) was reported to limit their ability to cross the intestinal tract wall by passive diffusion (Moser and McLachlan, 1999).

Table 1 Body weight, fatness, TCDD and PCB burdens at days 0 and 57 of depletion period.

	Day 0			Day 57			Difference (d 57 – d 0)			
	CTL	UFMO	SEM	CTL	UFMO	SEM	CTL		UFMO	SEM
Body weight (kg)	62	64	2.8	59	51	5.6	-3	*	-14	1.4
Empty body lipids (kg)	12.6	14.7	1.19	11.8	9.8	1.60	-1.0	*	-5.2	0.51
Empty body burden[1]										
TCDD (ng)	247	233	18.7	239	216	19.2	-8	*	-17	1.8
PCB 126 (ng)	220	241	42.0	227	236	40.9	+7	*	-6	2.2
PCB 153 (µg)	258	256	14.7	253	241	15.1	-5	*	-15	1.9

[1] Estimated burden at day 0 = burden measured at day 57 + amount of pollutant excreted over the depletion period through faeces and wool – amount of pollutant ingested over the depletion period. * CTL and UFMO means differs at $p < 0.05$.

Conclusion The current results combining a fine description at once of POP toxicokinetics and body lipid dynamics will be useful to calibrate mechanistic models aiming to predict the transfer of POP in ruminants and fine tune relevant strategies of decontamination.

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References

Lake IR, Foxall CD, Lovett AA, Fernandes A, Dowding A, White S and Rose M 2005. Environmental Science and Technology 39, 9033-9038.
Lerch S, Guidou C, Thomé JP and Jurjanz S 2016. Journal of Agricultural and Food Chemistry 64, 1212-1220.
Moser GA and McLachlan MS 1999. Chemosphere 39, 1513-1521.
Rozman K, Rozman T and Smith GS 1984. Bulletin of Environmental Contamination and Toxicology 32, 27-36.

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