▶ 10:30 - 11:50

Levels and Trends (Foods and Feeds)

M.Rose & H.Vanderperren

MON-AM-E4 Combining Quantification of Suckling Cow Exposure and PBTK Modelling for Risk Assessment of Beef Meat Contamination with dioxin-like PCBs

Agathe Vaille, Sylvain Lerch*

Ruminant Nutrition and Emissions, Agroscope, 1725 Posieux, Switzerland, sylvain.lerch@agroscope.admin.ch

Introduction: Swiss and German surveys of polychlorinated biphenyls (PCBs) contamination of meat from suckling cow herds have revealed occasional exceedances of the regulatory maximum level (ML, EU 1259/2011 regulation)[1,2]. Some of these contaminations could be attributed to diffuse sources of PCBs coming from soil ingestion, which is presumably higher in grass-based feeding systems[3]. A proper risk assessment of exceeding ML in meat relies on i) estimating cow oral exposure to PCBs (i.e., feed and soil intakes) and ii) quantify the transfer of PCBs from oral dosing to cow meat. The aims of the present work were to i) aggregate monitoring data from different databases for estimating PCB exposure and ii) quantify the corresponding PCB transfer into beef cow using a physiologically-based toxicokinetic (PBTK) model[4].

Materials and Methods: The quantification of the exposure to the 12 dioxin-like PCBs (dl-PCBs) of Swiss suckling cow herds have been estimated by collecting and merging 18 databases from scientific publications, Swiss federal and cantonal administrations, and the Swiss Mother Cow association. Combined exposure through feed (forages and concentrates) and soil ingestions was considered. Typical feeding systems for suckling cow husbandry in Switzerland were studied (mountains, hilly and lowlands areas, and farms using concentrate feeds, during winter and summer seasons)[5]. Three different levels of soil intake were assumed, covering the range measured in beef heifers at pasture[3]: 1%, 3% and 9% of total dry matter (DM) intake. The distributions of the concentrations in individual dl-PCB congeners in each feedstuffs entering suckling cow rations [fresh grass, hay, grass silage, corn silage, concentrates and "other"; *n*=132], as well as in Swiss rural and agricultural soils (*n*=26) were determined. Median, third quartile (Q3) and ninth decile (D9) exposure scenarios were further computed for each feeding systems and soil ingestion levels. The corresponding total diet dl-PCB concentrations were further used as input parameters into a PBTK model describing the fate of lipophilic contaminant in lactating cow[4], formerly adjusted for dl-PCBs using beef cow PCB toxicokinetic data[6] as a calibration dataset.

Results: The highest median dl-PCB level was observed in soil (0.38 ng $TEQ_{WHO\text{-}2005}$ kg^{-1} DM) followed by grass silage (0.13), hay (0.12), pasture (0.12), and other feedstuffs (in average 0.05). All the feeding systems (i.e., mountains, hilly or lowlands areas) comprised more than 85% (DM basis) of grass-based forages (mostly hay and grass silage during winter and pasture during summer). This led in nearly similar diet dl-PCB concentrations, across feeding systems and winter or summer seasons, which depended mainly on soil intake level and Median (in average 0.12, 0.12 and 0.14 ng TEQ kg^{-1} DM, for 1, 3 and 9% of soil), Q3 (0.17, 0.18 and 0.20) or D9 (0.24, 0.27 and 0.35) scenarios. None reached the regulatory feed action threshold (AT) set at 0.40 ng dl-PCBs TEQ kg^{-1} (277/2012 EU regulation). Nonetheless, according to the suckling cow PBTK model ran over five consecutive lactations, dl-PCB concentration in adipose tissues of the D9 scenarios might achieved up to 2.7, 3.0 and 3.9 pg TEQ g^{-1} lipids for 1, 3 and 9% soil intake, respectively. Those levels are higher than meat AT (1.75 pg dl-PCBs TEQ g^{-1} lipids) and close from ML (4.0 pg PCDD/Fs + dl-PCBs TEQ g^{-1} lipids) for 9% soil. The Median scenarios might lead to maximum adipose dl-PCB levels in the range 1.3-1.5 pg TEQ g^{-1} lipids, lower than meat AT, which was however overpassed for Q3 scenarios (maximum of 2.0-2.3 pg TEQ g^{-1} lipids).

Discussion and Conclusion: The present study highlights that even with diet dl-PCB levels lower than feed AT, there is a risk of exceeding the AT in meat of suckling beef cows for scenarios where feed and soil are contaminated above the median level (scenarios Q3 and D9). Investigations also confirm that when punctual sources (e.g., PCB-loaded barn materials and equipment, accidentally contaminated feedstuffs) are excluded from calculations, a major route of exposure to dl-PCBs is through soil ingestion. Additional monitoring data regarding PCB contamination levels in feeds and soils and their temporal trends would be needed to strength such quantitative risk assessment. This requires expanding and merging more federal, cantonal, and industrial monitoring plans and surveys. Ultimately, the methodological framework, based on combining disperse databases and PBTK modeling, will improve the decision-making process of feed and food safety risk assessors, and may further be extend to other contaminants (ndl-PCBs, PCDD/Fs, emerging POPs…) and farm animals (dairy ruminants, poultry, swine…). This would help advising farmers in order to avoid critical scenarios and prevent livestock contamination incidents.

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References:

1. BAG (2012) Dioxine und PCB in Rindfleisch aus naturnaher Produktion. *Bundesamt für Gesundheit*, 1–4.
2. BVL (2013). Berichte zur Lebensmittelsicherheit. *Bundesamt für Verbraucherschutz und Lebensmittelsicherheit*, 1-71.
3. Morel *et al.* (2022). *Animal - science proceedings*, 13(3):455-457.
4. Lerch *et al.* (2018). *Advances in Animal Biosciences*, 9:444.
5. Iten (2012). *Die Mutterkuh*, 12(4), 13-15.
6. Driesen *et al.* (2022). *Chemosphere*, 296:133951.