Results and discussion

Predictive performance did not differ among the developed equations with accuracies, sensitivity, and specificity ranging from 0.853 to 0.864, 0.881 to 0.950; and 0.388 to 0.727, respectively. Bloat instances were more adequately predicted than non-bloating instances. Lower specificities are attributable to a larger biological phenomenon of healthy animals. The LASSO, BiSR, and EN models had the highest performance statistics and were the most parsimonious (Table 1). Interestingly, NWIE persevered in these models, which could indicate behavioral modifications observed for bloating animals that may attempt to drink water to alleviate digestive disturbances, but cannot due to high ruminal pressures.

Conclusion and implications

The reported equations present satisfactory predictive ability, and therefore, could potentially be incorporated into individual cattle management systems as monitoring tool to assist both large and small feedlots that monitor intake behavior. They could assist in early detection of digestive disturbances that would allow managerial adaptations that could prevent further economic losses.

Financial support

A USDA-NIFA award #: 2019-69006-29329, the Paul and Daisy Soros Fellowship for New Americans, and the Richard Kleberg Agricultural Scholarship Endowment from the University of Nevada, Reno, provided funding.

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doi: 10.1016/j.anscip.2022.07.431

41. Effects of breed, growth rate and dietary lipid concentration on lipophilic contaminant accumulation into growing cattle: insight from a physiologically-based toxicokinetic model

J. Albechaalany [a,b,c,*], C. Loncke [a], C. Driesen [b,c], P. Schmidely [a], I. Ortigues-Marty [d], M. Zennegg [b], D. Sauvant [a,1], S. Lerch [c]

[a] Université Paris-Saclay, INRAE, AgroParisTech, Mosar, 75005 Paris, France
[b] Empa, Laboratory for Advanced Analytical Technologies, 8600 Dübendorf, Switzerland
[c] Ruminant Research Group, Agroscope, 1725 Posieux, Switzerland
[d] INRAE, Université Clermont Auvergne, Vetagro Sup, UMRH, 63122 Saint-Genès-Champanelle, France

[*] Corresponding author: John Albechaalany
E-mail: john.albechaalany@inrae.fr

Introduction

Ruminants occasionally face contamination incidents of persistent organic pollutant (POP; e.g., dioxins/furans) with economic and social damages (Driesen et al., 2022). Understanding the fate (absorption, distribution, metabolism, and excretion, ADME) of POPs at the animal level is key to ensure the safety of livestock systems. The rate of feed-meat transfer of POPs depends on animal physiology and feeding, as well as on contaminant physicochemical properties (Driesen et al., 2022). The objective was to explore this complex *animal×diet×contaminant* interaction using a mechanistic model and evaluate the effects of breed, growing rate, dietary lipid concentration and contaminant lipophilicity on feed-to-meat accumulation kinetics.

Material and methods

The physiologically-based toxicokinetic model (PBTK, Fig. 1) describes the transfer of a lipophilic contaminant from the feeder to the intestine, where it is excreted through feces or passively diffuses to the blood. From the blood, the contaminant distributes to adipose tissues, muscles, the liver, and the rest of the empty body by blood-perfusion and passive diffusion (adipose tissues). The changes with time of lipid masses in digesta and empty body are described according to the INRA feeding system (2018) and the growth model "MECSIC" (Hoch and Agabriel, 2004), respectively. Further details about the model framework are provided in Lerch et al. (2022). Simulation scenarios included Charolais bull and Angus-Hereford steer that grew slowly (SG; 9.0 MJ ME/kg DM) or fast (FG; 12.0 MJ ME/kg DM) from 200 to 600 kg BW, with lipid supplementation (LS; 59.6 and 72.15 g/kg DM) or without (NoneLS; 17.2 and 28.6 g/kg DM for SG and FG, respectively). The diet contaminant concentration was fixed at 0.57 ng TEQ/kg DM (action level for dioxins/furans, EU regulation 277/2012) for 23478-pentachlorodibenzofuran (23478-PeCDF; moderately lipophilic: octanol:water partition coefficient; K_{ow} $10^{7.1}$, clearance 0.65 d^{-1}) or octachlorodibenzodioxin (OCDD; highly lipophilic: K_{ow} $10^{8.4}$, clearance 1.0 d^{-1}).

Results and discussion

The simulated average daily gains of Charolais bull and Angus-Hereford steer were 0.81 and 0.88 for SG, and 1.20 and 1.35 kg/d for FG, respectively. Empty body lipid proportion increased for Charolais from 8.1% at 200 kg BW to 16.5% and 16.3% at 600 kg for SG and FG, respectively; and for Angus-Hereford steer from 11.3% to 28.4% for both SG and FG. The 23478-PeCDF accumulation kinetics suggested that the regulatory maximum level (2.5 pg TEQ/g lipids, EU regulation 1259/2011) would be overpassed in muscles by 4.4 and 3.7-fold in SG-

[1] In memory of Pr. Daniel Sauvant.

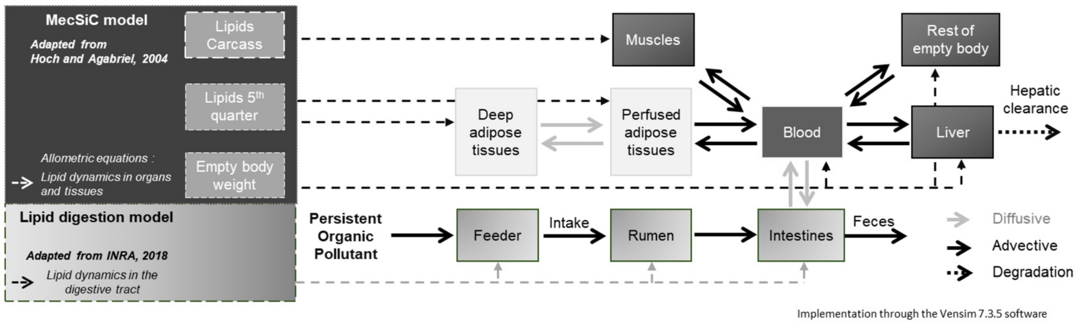

Fig. 1. Conceptual diagram of the physiologically-based toxicokinetic (PBTK) model describing the fate of lipophilic contaminants in growing cattle.

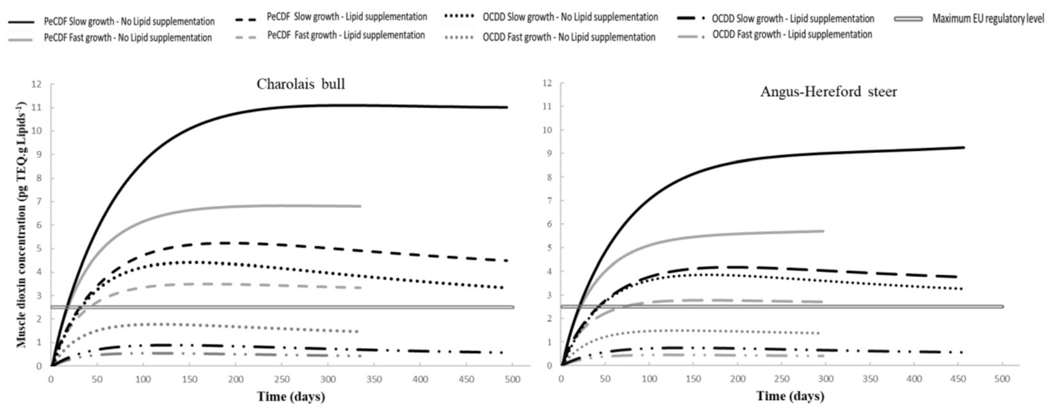

Fig. 2. Accumulation kinetics of 23478-PeCDF and OCDD in muscles of Charolais bull and Angus-Hereford steer, receiving low-energy diet (slow growth) and high-energy diet (fast growth) with or without lipid supplementation (5% additional lipid in DMI) from 200 to 600 kg BW. Diet 23478-PeCDF or OCDD concentration fixed at 0.57 ng TEQ/kg DM.

NoneLS, and by 1.8 and 1.5-fold in SG-LS, but only by 2.7 and 2.2-fold in FG-NoneLS, and 1.3 and 1.1-fold in FG-LS for Charolais and Angus-Hereford, respectively (Fig. 2). It suggests that lipid supplementation decreased the absorption rate of 23478-PeCDF and that fatter cattle (i. e., Angus-Hereford) efficiently reduced their tissue contaminant concentration due to a dilution effect into a larger amount of body lipids (Driesen et al., 2022). Similar observations were recorded for OCCD, but at much lower levels (only overpassed regulatory maximum level by 1.3-fold in SG-NoneLS). The higher lipophilicity of OCDD lowered its absorption rate when compared to 23478-PeCDF, as previously outlined experimentally (Driesen et al., 2022).

Conclusion and implications

The growing cattle PBTK model is promising to address the effects of different livestock systems on ADME and explore the complex *animal×diet×contaminant* interplay. Ongoing developments include the assessment of the model predictive capabilities to deliver a practical tool for risk assessors and managers, and ultimately contribute to beef meat chemical safety.

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doi: 10.1016/j.anscip.2022.07.432