Mechanistic model of metabolic use of dietary phosphorus and calcium and dynamics of body ash deposition in growing pigs: version 2.0

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Application A more precise estimation of phosphorus and calcium requirements in growing pigs will reduce these minerals utilization and excretion and increase the sustainability of the current phase-feeding systems.

Introduction Precision feeding may reduce phosphorus (P) and calcium (Ca) excretion and enhance sustainability but requires an accurate estimate of P and Ca requirements. Given the complexity of P metabolism because of multiple interactions, response criteria, and production objectives, mathematical modeling has been chosen to represent it. The aim of this paper is to update an existing model and evaluate its accuracy to predict growing pig body Ca and P repartition with the purpose of giving recommendations.

Material and methods Data (diet, body composition) of 4 experiments (Pomar *et al.*, 2006; Langlois *et al.*, 2016a and 2016b; Gonzalo *et al.*, 2018) were used to build an equation of the bone ash deposition potential independent of protein deposition. This has been done by using dietary treatments that exceeds the most Ca and P requirements (1 out of 17 treatments). In the remaining treatments, animals received 1) excess (control group), 2) deficient or imbalance (deficient group), and 3) deficient followed by control (depletion-repletion group) dietary Ca and P. The model prediction accuracy was assessed using mean squared prediction error (MSPE) and its decomposition into error of central tendency (ECT), regression (ER) and disturbance (ED).

Results and discussion The deposition dynamics is not the same for the different body tissues. In fact, there is no relationship between ash and protein deposition (Figure 1) as currently assumed in actual growth models (e.g., InraPorc, van Milgen et al., 2008 and NRC, 2012). With the new equation of the potential of Ca deposition into bone in relationship to bodyweight (BW, kg) ($Y = 6.46 + 4.49 \times 10^{-4} \times BW^2$; $R^2=0.76$), the model offers good prediction accuracy with MSPE of 6.7 and 7.8 % for P and Ca, respectively, which are mainly associated to disturbance error using the entire database (90 and 84 % for P and Ca respectively). However, in control group pigs it slightly underestimates body Ca and P (respectively, MPSE, 6.4 and 4.4%; ECT, 53 and 8 % for P and Ca). Conversely, Ca is overestimated in pigs fed deficient (MPSE, 8.7 %, ECT, 32 %) and depletion-repletion diets (MPSE, 7.3 %, ECT, 19.91). This overestimation is particularly important for body Ca in heavier body weight pigs (ER, 40.43 %) from deficient group. These results seem to be related to the lack of regulation of Ca and P metabolism especially bone resorption.

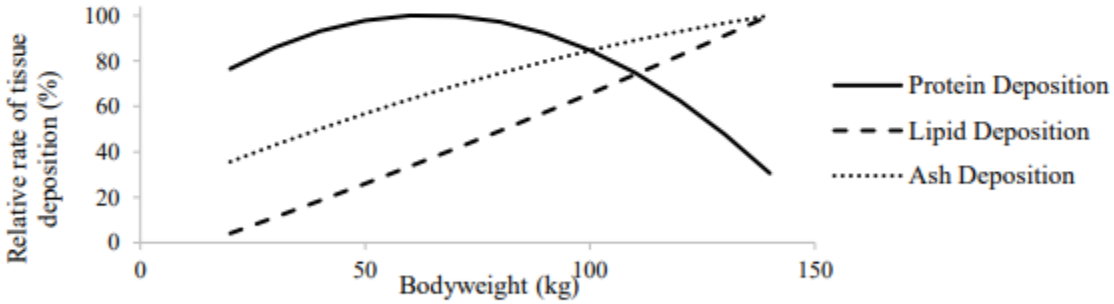

Figure 1 Relative rate of tissue deposition in relation to pig bodyweight

Conclusion The independency of bone ash deposition potential to protein deposition permits to obtain accurate prediction of body P and Ca in control group pigs, although a slightly underestimate remains. Next steps will be to improve accuracy of prediction in low Ca diets.

References

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