ENVIRONMENTAL IMPACT OF PHOSPHORUS EXCRETION IN LIVESTOCK: QUANTITATIVE ANALYSIS OF FLOW PHOSPHORUS USING BIO-MATHEMATICAL MODELS

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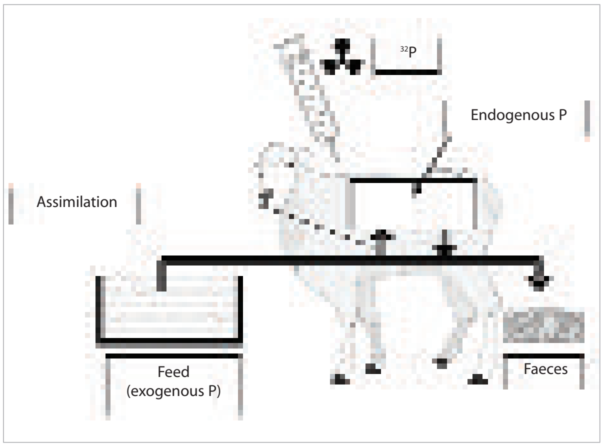

Figure 1. Schematic representation of the isotope dilution technique

Animal husbandry concentration in production areas greatly contributes to water and soil pollution through excessive nutrient dejection output. This study will be conducted to evaluate the environmental impact of phosphorus excretion in livestock and to obtain a better understanding and quantification of phosphorus excretion. Phosphorus metabolism will be evaluated by using radioisotope technique (*Figure 1*) and mathematical models. Various levels of phosphorus supplementation and/or different P sources will be given to the animals in their diet. After 21days pre-experimental period, each animal will receive a single dose of 7.4 MBq ^{32}P in 1 ml sterile isotonic saline at the right jugular vein. Blood samples, fecal and urine samples will be taken for 7 days. Specific activities in plasma and feces will be determined. Endogenous losses and true availability will be determined. After the end of the experiment, the animals will be killed by intravenous injection of pentobarbital. Tissues (liver, heart, kidney and muscle) and bone samples (12th rib) will be collected. Phosphorus metabolism will be evaluated using mathematical models.

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

Quantitative aspects of phosphorous metabolism have been considered using balance studies and kinetic models based on experiments with radioactive tracers. Using data from balance and kinetic studies, a model of P metabolism in growing goats fed with increasing levels of P was proposed by Vitti *et al.* (2000).

The proposed of P kinetics model was revised considering the study of calcium (Ca) flows in growing sheep (Dias *et al.*, 2006) (*Figure 2*). Sheep weighing 32 kg were injected with ^{32}P and ^{45}Ca to trace the movement of P and Ca in the body. The original model had 4 pools representing the gut, plasma, soft tissues and bone. In the revised model, instantaneous values rather than averages for pool derivatives were incorporated, and the model was extended to represent absorption and excretion of phytate P. The amendments improved the model, resulting in higher flows between plasma and bone than between plasma and tissue. Therefore a more accurate representation of P metabolism was obtained. Phosphorus and Ca metabolism were then assessed conjointly using the revised model. Dias *et al.* (2006) found that phytate P digestibility in the forage used to feed the animals was only 47%, and P retention was negative, suggesting that a characteristic feed impairs P utilization, resulting in P deficiency. The models described contributed to a better understanding of P and Ca metabolism in ruminants and non-ruminants being a support tool for diet assessments and their efficiency of utilization or pollution impact.

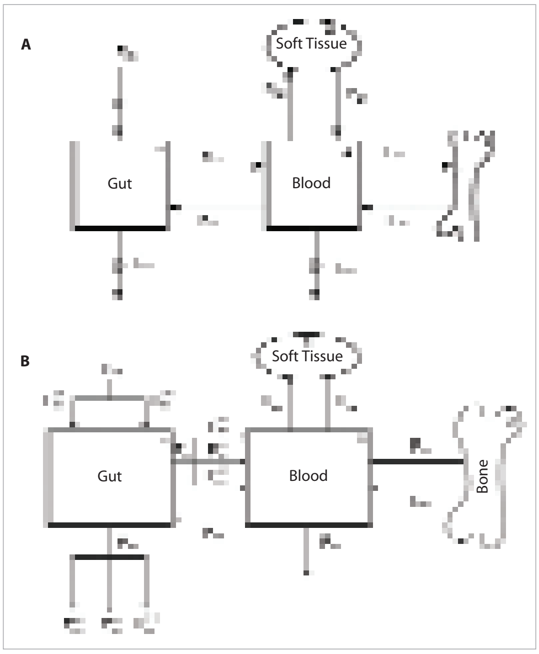

Figure 2. (A) Schematic representation of P metabolism model in goats. F_{ij} is the total flux of pool i from j, F_{i0} is an external flux into pool i and 0 a flux from pool j out of the system. Specific activities of pool i is represented by s_i and circles denote fluxes measured experimentally (Vitti et al.*, 2000). (B) Revised model of P metabolism in growing sheep showing phytate P. F_{10} denotes ingestion of P, F_{01} excretion of P in faeces, F_{02} excretion of P in urine. The flows F_{10}, F_{01}, and F_{21} are partitioned as shown, with superscripts (p), (e), and (n) indicating P of dietary phytate, re-cycled endogenous, and dietary non-phytate origin, respectively (Dias* et al.*, 2006).*

MAIN PUBLICATIONS

Dias RS, Kebreab E, Vitti DMSS, Roque AP, France J. 2008. Application and comparison of two models to study effects of calcium sources in sheep. *Animal Feed Science and Technology*. **143**: 89-103.

Louvandini H, Vitti DMSS, Abdalla AL, Mcmanus CM. 2008. Phosphorus kinetics in growing hair sheep. *Small Ruminants Research*. **76**: 183-189.

Vitti DMSS, Furtado CE, Quadros JBS, Lopes JB, Bueno ICS, Dias RS, Nozella E, Godoy PB. 2008. Effects of different levels of dietary calcium on calcium and phosphorus kinetics in horses. *Brazilian Journal of Animal Science*. **37**: 478-486.

Dias RS, Kebreab E, Vitti DMSS, Portilho FP, Louvandini H, France J. 2007. Phosphorus kinetics in lambs fed different levels of dicalcium phosphate. *Journal of Agricultural Science*. **145**: 509-516.

Roque AP, Dias RS, Vitti DMSS, Bueno ICS, Cunha AC, Santos LE, Bueno, MS. 2007. True digestibility of calcium from sources used in finishing lambs diets. *Small Ruminants Research*. **71**: 243-249.

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