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Meta-analysis of phosphorus utilisation by broilers: influence of dietary calcium and microbial phytase

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Introduction

Pollution relative to phosphorus (P) excretion in poultry manure but also the soaring prices of phosphate, a non-renewable resource, remain of major importance for the sustainability of this production. Thus, a good understanding of bird's response regarding dietary P is a prerequisite to optimise the utilisation of this essential element in broilers' diets. The use of microbial phytase represents one of the strategies developed during last decades to face this issue. In this context, to maintain performance, the nutritionists have to determine the most effective reduction in phosphorus in feed containing exogenous phytase and the optimal dietary conditions, especially the dietary concentration of calcium (Ca).

Materials & methods

A database was built from 15 experiments and 203 treatments to predict the response of 21-day old broilers fed corn and soybean meal based diet in terms of

Y = *Average daily gain (ADG), Average daily feed intake (ADFI), gain:feed and Tibia ash concentration*

to dietary concentration (/kg diet) of

X= *Non-phytate P (NPP), Microbial phytase (Aspergillus niger) and Calcium (Ca)*

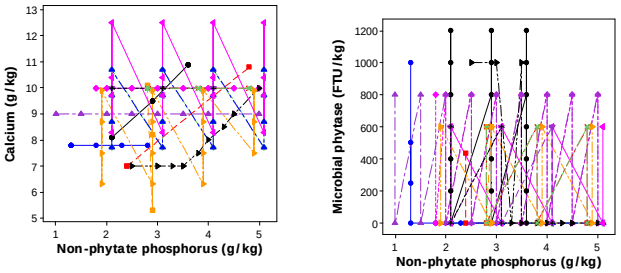
Taking into account the fixed effect of the experiment (Sauvant et al., 2008)

$$Y_{ij} = \alpha + \alpha_i + b_1 NPP_{ij} + b_2[NPP_{ij}]^2 + e_{ij}$$

where Y_{ij}, dependent variable Y in the experiment i with the level j of NPP; α, overall intercept with the condition that the sum of the effect of each experiment α_i is equal to 0; b_1 and b_2, linear and quadratic coefficients respectively, and e_{ij}, residual error.

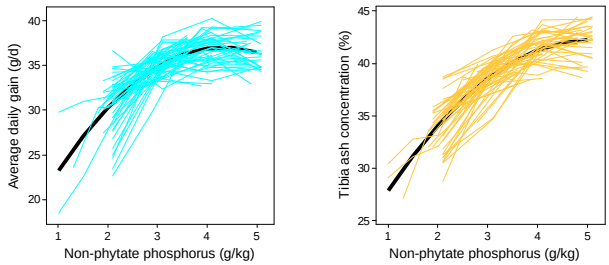
Results

Meta-design[1]



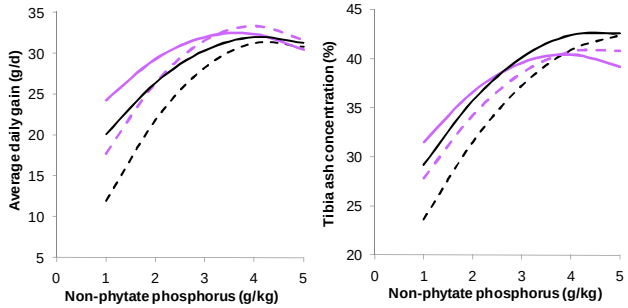
[1] Each point represents one treatment mean; points are linked within experiment

Responses to dietary non-phytate phosphorus[1]



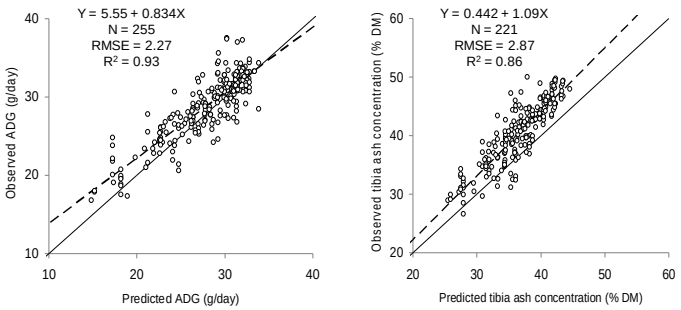
[1] Thin lines, within-experiment relationship; Thick lines, overall relationship

Statistical models



Response of average daily gain and tibia ash concentration to dietary NPP (g/kg) in broilers given diets with different Ca concentrations (in black, 10 g Ca/kg diet; in purple, 6 g Ca/kg diet) and phytase activity (dashed curve, 0 FTU/kg diet; continuous curve, 500 FTU/kg diet)

External validation of the models



Within experiment comparison between observed and predicted Average daily gain (ADG) and tibia ash concentration. (Each point represents one observation.; dashed lines, linear adjustment of observed to predicted values; continuous lines, first bisector ($Y_{obs} = Y_{pred}$)

Discussion and conclusions

The current models show that broilers are sensitive to P deficiency, in terms of growth performance and bone mineralization, P deficiency that is exacerbated in high Ca diets.

Also, it seems that growth performance and bone characteristics are both optimised in different conditions of NPP and Ca supplies, the optimisation of bone mineralization requiring more dietary Ca.

Furthermore, the response of broilers to supplemental P, here supplying through microbial phytase (*Aspergillus niger*), was higher when Ca was increased or when NPP was decreased (i.e. when P deficiency is increased).

These results point out the need to evaluate P sources, including phytase, in standardized conditions (mainly dietary P and Ca concentrations and response criteria considered).