Symposium: Phosphorus utilization evaluation in feed ingredients for poultry: Opportunities and challenges

593S Expressing feed phosphorus and requirement on a digestible basis. Olayiwola Adeola*, Purdue University, West Lafayette, IN.

Quantifying the portion of dietary phosphorus that can be used in the body of the animal is important for formulating nutritionally adequate diet and for efficient production of animal products. Available phosphorus in feedstuffs has been historically determined using the slope-ratio bioassay, which involves expression of response criterion to increasing concentrations of phosphorus from a test feedstuff relative to that from a reference source. The slope-ratio bioassay commonly engages a common intercept multiple linear regression procedure. The relative available phosphorus obtained from the assay is highly dependent on, among others, the available phosphorus in the reference source and the response criterion; and the measure is not usually additive in mixed feeds. The most common response criteria are bone ash, phosphorus concentration, or breaking strength, which tend to be labor-intensive and expensive, and very importantly do not provide estimates of the quantity of phosphorus voided by animals. The use of digestible phosphorus in place of relative available phosphorus overcomes some of the issues listed.

For the formulation of diets that more accurately match phosphorus requirement poultry with dietary supply as well as proper quantification of excretion of phosphorus for environmental considerations, the use of relative available phosphorus as a currency is nebulous. Because there is no difference between ileal and total tract digestibility of phosphorus in swine, standardized total tract digestibility of phosphorus was adopted in the 11th revised edition of the nutrient requirements of swine as the currency for expressing the requirements of pigs for phosphorus as well as the utilized phosphorus in feeds. In poultry however, because of the contribution of urine phosphorus to the excreta in total tract, ileal digestible phosphorus is more appropriate than total tract phosphorus as a response criterion. The research community is encouraged to generate more data on ileal digestibility of feed ingredients for poultry and that the feed industry and formulating nutritionists move away from relative available to ileal digestible phosphorus in diet formulation for poultry.

Key Words: phosphorus, requirement, digestible

594S Challenges for standardized phosphorus digestibility assays. Markus Rodehutscord*, University of Hohenheim, Stuttgart, Germany.

Determination of prececal digestibility of phosphorus (pcdP) has been suggested as the approach of choice to characterize the availability of P from feed raw materials and mixed diets in poultry. Mixed diets usually contain P sources of plant and mineral or animal origin. In plant feed raw materials, pcdP is closely related to gastro-intestinal degradation of phytate (any salt of phytic acid (myo-inositol 1,2,3,4,5,6-hexakis dihydrogen phosphate; InsP6)). The broiler has the potential to hydrolyze about two thirds of dietary InsP6 in low-CaP diets devoid of any phytase. However, supplements of Ca or P or both strongly reduce gastro-intestinal InsP6 hydrolysis and thus digestibility of InsP6-P. These effects can be compensated by concurrent supplementation of phytase, with compensatory effects being higher at dosages exceeding the industry standard level of supplementation. The standard protocol for the determination of pcdP of the World’s Poultry Science Association defined restrictions in regard to dietary P and Ca levels, but it does not consider interactions with InsP6 hydrolysis. Thus, pcdP values of non-plant P sources are underestimated if determined in diets that contain InsP6 and not corrected for InsP6 disappearance. Likewise, pcdP values of plant P sources are overestimated when used in diets that contain non-plant P sources. It is suggested that chemical analysis in pcdP studies is extended by InsP6 determination. This suggestion is supported by results of a P digestibility ring test where 17 stations from Europe and North America collaborated in. Although the same experimental diets were used in this study in all stations, the determined pcdP of soybean meal varied from 19% to 51% between stations. Prececal InsP6 hydrolysis correlated well with pcdP of the diets. It was concluded from the ring test that factors influencing InsP6 hydrolysis were main contributors to the variation in pcdP between stations. These factors were probably related to the feeding and housing conditions of the birds in the pre-experimental phase. Comparisons of P digestibility data from different studies must be made with great caution until the P digestibility protocol is more refined.

Key Words: phosphorus, digestibility, assays

595S Evaluation of phosphorus digestibility response to exogenous phytases. Mike Bedford*, ABVista, Marlborough, United Kingdom.

Phytases are routinely used to replace inorganic phosphates in commercial poultry rations. Inorganic phosphates are of value as most of the phosphate present is in the form of digestible phosphorus, ie a form that can be absorbed and subsequently used for growth and metabolic purposes. Phytases hydrolyse phytate (IP6) and its lower esters (IP5,4,3,2), from plant sources, making a previously poorly digestible form of phosphate more digestible, thus enabling replacement of inorganic phosphates. Thus the goal is to determine from a controlled, simple, in vivo assay, how much phytase needs to be used to produce a specific amount of digestible phosphorus, thus enabling a specific amount of inorganic P to be removed from the diet. Many factors can influence the digestibility value generated in any particular assay. Some of these are well known, particularly the level of calcium employed, age of the animal, vitamin D level of the diet. Nevertheless, the estimation of phosphorus digestibility from inorganic sources is subject to variation even when such parameters are controlled. More strikingly, it is clear from Dr Rodehutscord’s paper that the estimation of the digestibility of phosphorus from plant sources is much more complex and variable and may be subject to factors associated with the conditions the test animals are subjected to prior to the assay. Added to this is the further dimension that the efficacy of a phytase, ie the efficiency with which it can release phosphate from IP6 and lower esters, is moderated by the same factors that influence phosphate digestibility. As a result, a simple conversion factor between the phosphate provided from an inorganic source and the response to exogenous phytases is not correct, but depends upon the conditions under which the assay is conducted. The challenge for academia and the industry alike is to make sure these conditions are as close to those under which the phytase will be deployed so that its value is neither under or over-estimated.

Key Words: phosphorus, digestibility, phytases
Dietary calcium concentrations affect the determination of true phosphorus utilization. Kurt Perryman*, Micronutrients, McDonough, GA.

The effects of dietary calcium (Ca) concentrations on phosphorus (P) utilization are well documented. Increasing dietary Ca results in higher Ca:total P (tP) and Ca:non-phytate P (NPP) ratios, which have been demonstrated to attenuate the P utilization of feedstuffs. The World Poultry Science Association recommends maintaining a Ca:tP between 1.3:1 and 1.4:1 when determining true P utilization (TPU). This ratio was suggested based on previous research, as well as the use of a similar ratio in production poultry diets. However, due to inherent differences in feedstuff phytate P and NPP, it is impossible to simultaneously maintain the Ca:tP and Ca:NPP ratios when formulating titration diets required for the determination of TPU. The addition of Ca to maintain a constant Ca:tP ratio causes the Ca:NPP to become progressively higher with each sequential inclusion of the test feedstuff. Increasing the Ca:NPP results in lower P availability. Further complicating the situation, recent attempts to determine the TPU of several feed ingredients resulted in the prediction of negative endogenous P losses (EPL), which are physically impossible and occur as a consequence of regression analysis. It is likely that negative EPL result in the underestimation of TPU. Negative EPL may be attributed to increasing Ca:NPP in titration diets that maintained a fixed Ca:tP. In most cases where negative EPL were reported, researchers fed titration diets with a fixed Ca:tP. Conversely, positive EPL have been reported when Ca:NPP of titration diets were fixed or maintained below 2.2:1. Furthermore, formulating titration diets with a fixed Ca concentration produced positive estimates of EPL. Before a database of feedstuff TPU values can be generated, a consistent Ca feeding strategy must be established. Although using a fixed Ca:tP was initially suggested, the reported predictions of negative EPL may indicate a limitation to this approach. Researchers predicted positive EPL when titration diets had a fixed Ca or Ca:NPP ratio. However, maintaining a constant Ca:NPP may also have limitations, as certain feedstuffs have very low concentrations of NPP. Therefore, formulating titration diets with a fixed Ca concentration may be the most versatile method for the accurate determination of TPU.

Key Words: phosphorus, calcium, dietary