



Advances in poultry nutrition

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ABSTRACT - Nutritional advances as discussed in these proceedings embrace historical perspective as well as futuristic perspectives. Indeed, we must have a clear understanding of the past to identify key “advances” that will mold the future of poultry nutrition. Early nutrition research is discussed with reference to *in ovo* nutrition and nutritional needs up to day seven post-hatch. In addition, the nutrition of the hen is key in early nutrition of chicks. Key advances that have impacted diet formulation are energy and nutrient liberating enzymes, and the use of L-threonine. Key nutritional mechanisms that have been elucidated the past two decades include nutrition in immunity and gut health. Advances in nutritional specifications for specific genetic strains of broilers and the use of models to tie nutrition into production objectives are clear advances that will only flourish in the future.

Key Words: immunity, L-threonine, gut health, nutrition “*in ovo*”, nutrition up to seven days post hatch, nutrient liberating enzymes

Avanços na nutrição de aves

RESUMO - Os avanços nutricionais discutidos neste trabalho compreendem um histórico do passado bem como uma perspectiva para o futuro. Na verdade, nós devemos ter a clara compreensão do passado para identificar os avanços chaves que moldarão o futuro da nutrição de aves. A pesquisa sobre a nutrição na fase inicial é discutida “*in ovo*” e na fase inicial até sete dias de idade. Além disso, a nutrição da reprodutora é chave para a nutrição na fase inicial dos pintinhos. Os avanços chaves que possuem impacto sobre a dieta, aqui comentado, são a liberação de energia e de nutrientes por enzimas e o uso de L-treonina. Os mecanismos nutricionais chave que foram elucidados nas duas últimas décadas incluem nutrição na imunidade e saúde intestinal. Avanços na nutricional específica para as linhagens de frangos existentes e o uso de modelos para realizar uma nutrição específica para alcançar determinados objetivos de produção são avanços que ocorrerão somente no futuro.

Palavras-chave: disponibilidade de nutrientes, imunidade, L-treonina, nutrição na fase *in ovo*, nutrição na fase inicial, saúde intestinal

Introduction

These proceedings accompany a presentation on Advances of poultry nutrition. It is not the intention of these published proceedings to review all aspects of “advances in poultry nutrition”, but to address key advances that should spearhead future research in poultry nutrition for the sustainability of poultry production in an environmentally friendly manner.

Advances in nutrition arise when investigators pool knowledge of biochemical and physiological mechanisms to understand a response or interrelationship. Knowledge of the functionality of nutrients within cells in poultry has been carried out since the 1930's. Advances in poultry nutrition have gone from the “discovery” mode in a relatively

inefficient model to an “investigative” mode in an extremely efficient model used for the production of nutritious meat. In a review article by Coates (1962) he points to the pros and cons of using poultry as an experimental model. Interestingly, he points to the variability of the bird, which is due to lack of inbreeding, as the most problematic research con with poultry as compared to more genetically uniform research models. Clearly this is not the case at present. As the research of the past (1930's though 1960's) used chicks as a research model, usually metabolism trials with birds reared on wire, to discover and elucidate mechanisms for numerous vitamins, research of the present is more geared toward improving the efficiency of commercial poultry by increasing feed utilization and increasing desired carcass attributes.

Early nutrition

The genetic potential of the bird is dictated by early nutrition. What is early nutrition? Many markets around the globe dictate a carcass from a bird processed at 42 days. In this scenario, the bird has spent 33% of its life in the egg. Recent research has addressed in ovo feeding and concluded that impacts on subsequent broiler growth should be studied further. Furthermore, research has shown that the nutritional consumption of the hen further dictates the ability of the bird to meet its' genetic potential. Glycogen supply during the hatching process and early growth are improved via in ovo feeding. Moreover, feeding hens diets varying in a myriad of nutrients impacts early chick development and carcass development (Kidd et al. 2003).

Improving the efficiency of utilization and using nutrition to maintain a good environment

The efficiency of poultry production usually is not the reason discussions of greenhouse gases, nitrogen release from poultry farms, nutrient runoff into ground or surface waters arise. Environmental challenges are a key issue for poultry companies globally. The advances in nutritional strategies to minimize nutrient output and improve on-farm nutrient balance have been substantial. It must be pointed out that nutritional interventions will not solve environmental issues, but future nutritional research will be paramount to mimic production situations and rear poultry in an environmentally friendly manner. Below are two areas of nutrition (enzymes and amino acids) that allow for better meeting the birds' needs.

Energy and nutrient liberating enzymes

Although enzymes have been researched for some time, their commercial applicability has been limited to the past two decades. The initial inclusion of enzymes occurred in diets that utilized wheat, barley, or triticale, as their efficacy was to increase nutrient digestion by removing non-starch polysaccharides.

The inclusion of phytase has allowed nutritionists to closer meet the phosphorus requirement while decreasing phosphorus excretion of poultry. However, research on the efficacy of phytase products is not conclusive. Selle and Ravindran (2007) reviewed the literature and concluded that the efficacy of phytase products is not yet known. Not only will a better understanding of the efficacy of phytase products better allow closer meeting the birds' phosphorus needs, but also allowing in potential energy sparing effects. Enzymes that release energy (e.g., non-starch poly saccharide enzymes,

amylases, phytases, and proteases) will be of value as poultry companies continue to compete for energy sources with other industries.

Amino acid supply

Research within the last 15 years has established that threonine should be expressed relative to 0.63 to 0.70% of dietary lysine, of which mostly depends on gender, strain, diet, and age (Kidd, 2002). Although the ideal protein concept utilizes the threonine to lysine ratio, research in the past decade has been instrumental in demonstrating the importance of adequate threonine to assure good carcass yields as mediated by threonine supply allowing for proper function of lysine and methionine. Further, threonine's importance for mucin has been instrumental in Brazil to adapt threonine needs for broilers fed all vegetable based diets. Of most importance now is the assessment of limiting amino acids after threonine and how they impact broiler performance in practical settings. In addition to valine and isoleucine, more research is needed with glycine and possibly other non-essential amino acids or combinations of non-essential amino acids that limit the practical reduction in dietary crude protein. The next crystalline amino acid to be manufactured for poultry diets will revolutionize amino acid supply for poultry.

Nutritional interactions

Nutrition and gut health

In the former cited paper by Coats (1962) it was stated that "one of the broader problems at present concerning nutritionists is the relation of the microbial population of the alimentary tract to the nutrition of the host." Hence, for half a century we have discussed the same issue. Now that fewer anti-microbial products are being developed and some feeding programs are restricted in the use of anti-microbials, a better understanding of intestinal microbiology is warranted. Research with in ovo feeding has shown improvements in intestinal development (Tako et al., 2005), which translates into improved growth rate and efficiency. As previously discussed, enzymes have the potential to alter gut microflora.

Nutrition and the immune response

There has been a tremendous amount of research addressing nutrition and the immune response, especially the last 20 years. Kidd (2004) reviewed the responses and stated that numerous nutritional deficiencies and excesses impact the birds' ability to respond to infection. A better understanding of how to optimize antibody titers to antigens

of concern and downplay innate responses to ubiquitous stimuli is needed.

Using poultry nutritional models to optimize “poultry company complex” efficiency

We have gone through an era of using least cost models to predict ingredient choices and formulate complete broiler feed to an era of extrapolating broiler performance as affected by feed as a predictor of a profitable broiler complex. Indeed, there are a number of models being introduced that aid in the prediction of poultry performance. It must be pointed out that the models are only as good as the data used to establish them. One example of such model is the Holo-Analysis which accumulates published research data for specified variables and fits results into an empirical model (Rosen, 2006). Companies must create data bases to compare their performance to historical trends, other companies, and the literature.

Genetics and nutritional genetics

When discussing the efficiency of poultry production both nutrition and genetic selection come to mind. It must be pointed out that the bulk (80-90%) of the improvements in broiler growth are attributable to genetic selection (Havenstein et al., 2003). Hence, leaving nutrition and management making up the remaining 10-20%. However, Havenstein et al. (2003) demonstrated further improvements with the Ross 308 broiler versus the Athens-Canadian Randombred Cross of 1957 when birds were fed “modern” 2001 diets. Genetic selection, nutritional programs, and management systems that are efficient have shaped the broiler industry today. In the U.S., we have seen an 87% increase in poultry products from 1978 to 2002 relative to beef and pork products. Future nutritional advances should consider broiler strain.

Feed intake and growth patterns of modern broilers, however, vary. It is clear that research must continue in the area of nutritional responses to varying dietary considerations. Hence, predicted growth or yields for Ross crosses versus Cobb crosses are indeed different. A decade of research at Mississippi State University was carried out to better understand amino acids needs of Ross strains. In this research, performance efficiency and yields were assessed, sometimes in relation to economic conditions of poultry meat products. For example, Kidd et al. (2005) assessed amino acids needs of Ross 708 broilers and determined the critical need for early amino acid supply, in addition to validating the response economically. Dozier et al. (2008) further assessed the decade of work and established models to

predict amino acid needs of Ross birds to maximize feed conversion and meat yields.

Understanding which genes are turned on given a specific diet or nutritional profile may allow poultry nutritionists to uncover key fundamental problems in poultry production: how do I get more energy from soybean meal or how can I decrease crude protein beyond the norm and maintain equal growth? Corzo et al. (2009) is working towards elucidating intestinal amino acid transporter regulation as affected by diet. His initial research has determined that a reduction in some dietary amino acids upregulates some amino acid transporters. This work points to the importance of dietary amino acid supply on protein absorption and expression (Corzo et al., 2009). Determining strain specific effects of protein supply on transporter expression is warranted. Furthermore, Dr. Ferket recently provided a webinar for Watt Poultry (Ferket, 2009) and he indicated that in ovo feeding can dictate gene expression. Further, it may be that some of the nutritional impacts of breeders on chicks is mediated through gene expression, rather than a nutrient responses per se.

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