Update on amino acid requirements for broiler chickens. P. Tillman*1 and W. Dozier2, 1Poultry Technical Nutrition Services LLC, Buford, GA, 2Auburn University, Auburn, AL.

Broiler production and nutritional practices are rapidly changing due to demands for Raised Without Antibiotics meat, improved meat quality, changes in either conventional or to heritage breeds, and concerns over environmental impact, animal health and animal welfare. All of these changes can alter the optimal amino acid “requirement,” depending upon whether the goal is improving average daily gain, feed conversion, yield, profitability or one or more of these goals. Raised Without Antibiotics production, often accompanied with a transition to all vegetable-based diets, places more emphasis on “gut health” and perhaps a change in ingredients to be considered. The transition to vegetable-based diets may also alter the order of amino acid limitation and requires more emphasis to be placed upon key amino acids such as valine and glycine. White-stripping, wooden breast and other breast myopathies may impact targeted growth rates, market bird weights and thus days to market until resolved through genetic selection or some other means. Increased growth rate and feed efficiency of modern “fast-growing” genotypes and a trend toward the opposite end of the spectrum (i.e., “slow-growth”) both emphasize the need to better understand the amino acid and energy “requirements” of these vastly different broilers. As there is no single “requirement” for any given amino acid, as this depends upon the desired outcome – the concept of meeting more than one of these targets is daunting. Each of these changes, can have positive and/or negative impacts upon each of the aforementioned goals and ultimately on profitability. In addition, the role of several if not every essential amino acid can be involved in most of these key areas of interest. This paper will provide a North American summary of some of these current research areas, with a focus on the broilers “requirements” and some functional properties of certain amino acids.

Key Words: amino acids, reduced protein, requirements, broiler

Functional amino acids in poultry nutrition: Recent developments and practical applications. G. Wu*, Texas A&M University, College Station, TX.

Based on growth or nitrogen-balance studies, amino acids (AA) had been classified traditionally as nutritionally essential (EAA) or nonessential (NEAA) for poultry. For example, glutamate is quantitatively the most important energy substrate for enterocytes of 0 to 42-d-old chickens, whereas glutamine is a major metabolic fuel in chicken skeletal muscle. Growing evidence shows that some EAA (e.g., arginine, glycine, leucine and tryptophan) and NEAA (e.g., glutamine) can activate the mammalian target of rapamycin (mTOR) cell signaling to promote protein synthesis and inhibit proteolysis in tissues. Certain AAs (e.g., arginine, cysteine, glutamine, glutamate, glycine, proline, and tryptophan) also play important roles in regulating gene expression, male and female fertility, acid-base balance, redox signaling, detoxification of xenobiotics and endogenous metabolites, neurotransmission, and immune responses. Furthermore, some AAs (e.g., threonine and tryptophan) are crucial for intestinal mucosal integrity and anti-oxidative signaling. These findings lead to a new concept of functional AAs (FAAs), which are defined as those AAs that regulate key metabolic pathways to improve the health, survival, growth, development, and reproduction of animals. As examples for translating this novel concept to feeding practices, supplementing FAAs to conventional corn- and soybean meal-based diets enhances weight gain, skeletal muscle mass, and nutrient absorption and utilization, while reducing abdominal fat, plasma lipids, and mortality in broilers, particularly under conditions of inflammation, infection, and heat stress. Improvements in poultry feed efficiency and productivity through the use of FAAs will not only reduce the contamination of soils, ground-water, and air by excessive manure, but will also help sustain poultry agriculture to produce high-quality protein for the expanding population in the face of diminishing resources worldwide.

Key Words: amino acid, poultry nutrition, growth, immunity, health

Health and welfare improvements with low-protein diets and amino acids—Importance of threonine. L. Star*1 and W. Lambert2, 1Schlothorff Feed Research, Lelystad, the Netherlands, 2Ajinomoto Eurolysine S.A.S., Paris, France.

Reduction of crude protein (CP) in poultry diets is of interest for several reasons. First, there is an economic interest. Lower CP level in the diet will reduce the dependency on foreign feedstuffs, reduce use of GMO products, and reduce feed prices. Second, lower CP level is of interest for welfare. Excess of CP leads to a greater need of water to achieve efficient nitrogen excretion and this might results in degradation of litter quality and increase of foot pad lesions. Besides, a high CP level is a predisposing factor for the occurrence of necrotic enteritis. Third, reducing CP level in the diet is of interest for the environment. CP levels in the diet will have a direct effect on excretion of N. Excreted N can be very quickly converted to ammonia (NH₃). Reduction of CP in poultry diets is possible, but we should be aware that AA will not become limiting. If one essential AA does not meet the bird’s requirement, it will be limiting for production performance. Therefore, the ideal AA concept should be applied to make sure that essential AA are provided by feed. Several feed grade AA are routinely incorporated into poultry feeds. These AA are available at a price that permits their use in least-cost formulated diets. With these feed grade AA it is already possible to reduce CP in poultry diets and thereby reduce N excretion. It is expected that in the near future, the next limiting AA will become available at reasonable price for poultry feed. This will result in an even more accurate supply of AA to meet the need requirements of the bird. Results on performance of birds fed low CP diets are not consistent in literature. Used levels of CP, essential AA and non-essential AA differ between studies. One assumption is that digestible glycine (dGly) might be limiting in low CP diets, and thereby digestible threonine (dThr), because Gly can be metabolized from Thr. Therefore, the sparing effect of dThr on dGly in practical broiler diets was investigated. Besides, Thr is particularly important for mucin synthesis and maintenance of gut barrier integrity. Standard dThr-to-digestible lysine ratio suited for healthy birds can cause Thr deficiency in birds with intestinal problems resulting in loss of performance after infection. Three broiler trials to test dThr level during necrotic enteritis infection. The studies showed the importance of dThr in low CP diets as well as in broilers with intestinal health problems. It was concluded that a sufficient dThr level dGly was not limiting, and to support broilers with intestinal health problems, dThr can be supplied at a higher level.
Key Words: low crude protein, threonine, glycine, intestinal health, excretion

585S  Use of feed-grade amino acids in low protein diets: Towards a more sustainable broiler production? B. Meda*1, P. Bellioir2, W. Lambert1, M. Lessire1, and S. Tesseraud1, 1INRA, Nouzilly, France, 2Ecole d’ingénieur de Purpan, Toulouse, France.

In Europe, consumers and citizens are questioning the sustainability of broiler production, as they are waiting for affordable poultry meat produced with low environmental impacts and high animal welfare. The origin of the feed ingredients is also a growing concern since a more local production, without GMOs, is expected. In this context, reducing dietary crude protein could be an interesting strategy to simultaneously decrease nitrogen excretion of birds and the European dependency to GMO soybean meal importations. The aim of this study was thus to investigate the effect of decreasing dietary crude protein (CP) in finishing broiler on animal performance, meat quality and environmental impacts. PM3 Ross male broilers were reared together between 1 and 20d of age. At d21, they were randomly distributed in 24 floor pens (8 pens per treatment; 38 birds per pen) and fed until d35 (slaughter) with diets formulated with an amino acid (AA) profile based on the ideal protein concept. More specifically, the minimum AA:Lys ratios proposed by Mack et al. (1999) were used with modifications for Thr and Arg (Thr:Lys ratio increased from 63 to 68% and Arg:Lys ratio decreased from 112 to 108%, respectively). CP contents of experimental diets were 19, 17.5 and 16%, respectively. With CP reduction, the proportion of soybean meal in diets decreased (28, 24 and 18%, respectively), while those of corn and feed-grade AA increased (for AA: 0.23, 0.48 and 1.19%, respectively). CP reduction did not affect body weight (BW) gain, feed efficiency or breast meat yield but abdominal fat increased. Meat quality criteria responded to dietary CP reduction with higher ultimate pH and lower lightness and drip loss, but these variations were considered acceptable for meat preservation or processing. Nitrogen excretion decreased with CP (<12% per CP point) and so did volatilization. A life cycle analysis was also carried out to compare the environmental impacts of one kg of BW at farm gate, with 19 or 16% CP in finishing diet respectively. CP reduction decreased climate change, eutrophication and energy use impacts by 8, 7 and 1%, respectively. For acidification, the impact per ton of finishing diet increased by 4%, but the final impact decreased by 5%, due to decrease in nitrogen excretion and volatilization. In conclusion, CP reduction in finishing broilers is therefore possible using an adapted AA profile and feed-grade AA. Such a feeding strategy could improve the sustainability of broiler production with similar animal performance, no detrimental effect on meat quality, lower environmental impacts and a reduced use of GMO soybean meal.

Key Words: meat quality, amino acid, muscle, postmortem metabolism

587S  Effect of low-protein diets on nitrogen utilization, daily water consumption, and litter quality in broilers through meta-analysis approach. M.-P. Montminy*1, W. Lambert2, and O. Cirot2, 1Université Laval, Quebec, QC, Canada, 2Ajinomoto Eurolysine, Paris, France.

Reducing dietary crude protein (CP) is the most efficient strategy to reduce nitrogen (N) excretion by broilers that has also been reported to improve litter quality through reduction in water consumption and litter moisture (LM). Given the high amount of data available in literature on dietary CP reduction in broilers, a meta-analysis was performed to quantify the impact of reducing CP on N balance (N intake, excretion, retention, and retention efficiency), daily water consumption (DWC), and uric acid in serum or plasma express in percentage of the highest CP value (UA). The effect of the trial has been tested as a random effect and those of supplying the indispensable amino acids (IAA) at their requirement or not (IAAreq and IAAnot-req) and bird age (0–21 or 21–42 d) were also investigated as fixed effects in this meta-analysis. Based on a data set of 116 trials for N balance criteria, the analysis revealed that reducing the dietary CP linearly decreases N intake (P < 0.001; R² = 99%) and N excretion (P < 0.001; R² = 99%) with a higher effect for 21–42 d than 0–21 d broilers for excretion (CP × Age, P < 0.001). Besides, reducing dietary CP increases linearly the efficiency of N utilization (P < 0.001; R² = 98%) without impact of IAA level or age, meaning that age effect observed on N excretion is due to a higher consumption. Nitrogen efficiency of broilers can thus be increased by 2.3% per % of dietary CP reduction. Based on a data set of 22 trials for DWC, the analysis revealed that DWC of broilers (expressed in proportion to the highest CP level within trial) decreases linearly with the reduction of dietary CP level (P < 0.001; R² = 72%); increasing CP by 1 point % increases DWC by 2%. Regarding LM, based on 12 trials, the response to CP (P < 0.001; R² = 67%) showed that the LM of broiler might be reduced by 2.4% per point % of dietary CP reduction. Finally, based on 28 trials, UA increased in a linear (P = 0.02) and quadratic (P = 0.04) manner (R² = 57%) with increasing dietary CP, probably due to an excess of amino acid, until a plateau reach around 20 to 21% CP. Given the low R² obtained for DWC, LW, and UA, other X variables maybe implicated in these responses. This meta-analysis helps to quantify the effects of reducing dietary CP levels on N balance and on the litter quality of broilers. The combined reduction of N excretion and LM when reducing the dietary CP level may decrease the occurrence of footpad dermatitis by improving the litter quality. These results are useful to formulate low CP diets for a more sustainable broiler production.

Key Words: protein, amino acid, sustainability, environment, soybean meal

586S  Modulation of chicken meat quality by protein and AA nutrition. C. Berri*1, P. Bellioir2, M. Lessire1, S. Metayer-Coustand1, and S. Tesseraud1, 1BOA, INRA, Université de Tours, Nouzilly, France, 2Ecole d’ingénieur de Purpan, Toulouse, France.

Poultry products are mainly consumed as cut and processed products. Therefore, it is no longer enough for broilers to have high slaughter yields but sensorial and functional characteristics of meat must be taken into consideration to satisfy the demands of both processor and consumer. This review focuses on the recent advances showing that nutrition can be an effective tool to control muscle development and meat quality in poultry. In particular, the intake of protein and amino acids, which largely determines muscle growth and yield, may affect several molecular pathways with significant consequences on muscle postmortem metabolism and meat quality. Indeed, the amino acid supply during the finishing period or just before slaughter can shape the energy reserves of the muscle with a significant impact on meat quality, including color, processing yield and susceptibility to oxidation. Beyond the control of muscle metabolism, protein intake will also be crucial in controlling the molecular pathways that influence muscle fiber growth and integrity. Thus, recent studies show that in modern heavy strains, improving meat yields by nutrition can also lead to poor meat quality, and in the most severe cases to the onset of myodegenerative defects, such as white striping or wooden breast. Therefore, it is essential to rethink poultry nutrition and optimize dietary supplies (quantitative and qualitative) over time and in function of production targets.

Key Words: low protein, amino acid, muscle, postmortem metabolism