Dietary nitrogen reduction can improve the nitrogen balance

In Germany, revisions to regulations governing fertiliser use and the management of nitrogen and phosphorous at farm level are expected to add to pressure on the animal industry to further reduce the level of emissions. The suggested values for the annual nitrogen excretion per place and year are more ambitious than those suggested by European regulations.

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Estimates based on key numbers from current broiler feeding practices imply that it might be extremely challenging to meet these threshold values. Consequently, farmers might be forced to run fewer cycles per year or to reduce the number of animals per square metre. Alternatively, reducing the dietary crude protein (CP) with subsequent reduced nitrogen excretions could be an appropriate strategy.

To help assess this last option, a broiler feeding trial was conducted on a commercial farm as a partnership between the University of Applied Sciences Osnabrück, a German feed compounder, and Evonik. Commercial diets with and without dietary CP reduction were provided to 420,000 broilers and the impact of these diets on performance, nutrient utilisation and economics was evaluated.

Experiment outline

A total of 420,000-day-old male and female (as hatched) Ross 308 chicken (41.0g/chick) were allocated into 10 commercial barns with 42,000 birds each. The temperature programme was in line with breeder recommendations.

At day one birds received 24 hours of light. This was reduced to 22 hours on days two and three and thereafter to 18 hours.

Broilers received a standard vaccination programme against infectious bronchitis and Newcastle disease. Each barn measured 1,800m^2 (23 birds/m^2) and was equipped with four feeding lines and six nipple drinker lines for ad libitum supply of feed and water.

One ton of dried corn silage per barn (0.56kg/m^2) was used as bedding. The volume was identical for each barn and no extra bedding was applied in any of the barns during the experiment.

A four-phase feeding programme was applied, comprising a starter (days 1-10), a grower I (days 11-20), a grower II (days 21-25), and a finisher period (days 26-end).

Because the first thinning crop took place at day 29, feeds free of coccidiostats were introduced from day 26.

Wheat-corn-soybean meal-based diets were formulated according to commercial practice. Accordingly, treatment 1 (TRT 1) represented commercial standard feeds while in TRT 2 CP levels were reduced in grower I, grower II, and finisher feeds. From each produced feed batch, samples were taken for analysis adding up to a total of 97 samples.

Analysis of amino acids indicated that expected values were exactly met. Moreover, there was no variation between samples within treatment and phase. However, with respect to CP, analysed values differed from expected values and up to 0.7%-points higher values were found. Accordingly, the CP level of TRT 2 was 0.4%-points lower than that of TRT 1 considering the entire feed consumption per barn instead of the calculated 0.5%-points.

Amino acids carry about 90% of total nitrogen, and there is no reason to assume that other non-protein-nitrogen affected total nitrogen. Nevertheless, analysed levels were used for nitrogen balancing calculations instead of declared nitrogen levels.

All diets contained a phytase and a xylanase, but amino acid-releasing impact was not considered in feed formulations. Starter, grower I and grower II feeds contained coccidiostats, while finisher feeds did not. Pelleted feeds were produced in a commercial feed mill.

Feed consumption was recorded after each feeding phase, while body weights and number of birds were recorded over the entire production cycle for each barn. Average body weights, average feed intake, feed conversion ratio (body weights of losses considered) and mortality were calculated accordingly.

Efficiency based on biological performance

The European Efficiency Index (EEI) was calculated based on biological performance.

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At days 29 and 34 about 24% and 20% of the birds were harvested respectively, leaving 56% of the birds for the main crop during days 40, 41 and 42.

With respect to the delivered live weight, the first, second and third crop accounted for about 16, 17, and 67%, respectively.

Birds were slaughtered at commercial slaughterhouses. However, while it was possible to get footpad scoring data (camera scan) for each crop and barn, this was not the case for further carcase traits. Water consumption was recorded for each barn.

At termination of the experiment, litter quantity was determined for each barn by means of a tractor with an installed scale.

Finally, nitrogen balance and nitrogen utilisation were calculated assuming 30g nitrogen/kg body weight.

Data were analysed by one-way ANOVA using R-statistics. A barn served as an experimental unit.

Moderate reduction of dietary CP did not negatively affect performance

Final body weights both for each crop and for the overall average did not differ between treatments. Birds in TRT 2 tended to consume less feed compared to those in TRT 1.

However, this was not reflected in the average feed conversion ratio nor in the EEI serving as a productivity indicator.

As such, moderate reduction of dietary CP by 0.4% in overall consumed feed did not negatively affect performance at any of the crops suggesting adequate supply of essential amino acids.

Birds in TRT 2 consumed 4% less water and excreted 9% less nitrogen than those in TRT 1.

Metabolically, nitrogen excretion requires water and therefore the improvement in nitrogen utilisation observed in birds fed lower CP levels is a good indicator of their reduced water requirements. Moreover, lower water intakes for TRT 2 birds resulted in 12% less litter produced.

Litter moisture and ammonia content negatively impact the footpad health of broilers. In the overall production cycle, there was no issue with footpad health in general.

Nevertheless, birds in TRT 2 tended to have a higher incidence of Grade 0 and a lower incidence of Grade 1 footpads than TRT 1.

Average moderate reduction of dietary CP reduced nitrogen intake and excretions

With respect to the nitrogen balance calculations, the average moderate reduction of dietary CP by 0.4%-points reduced nitrogen intake by 4% and nitrogen excretions by 9% in TRT 2 compared to TRT 1.

Extrapolating the average reduction of dietary CP to 1%-point would, thus, have the potential to reduce nitrogen excretions by 22%. Therefore, even small reductions in the nitrogen content of broiler diets can considerably reduce nitrogen output and therefore improve the nitrogen balance of commercial farms.

Conclusions

Compared to commercial standard feeds fed to control birds (Treatment 1: n = 210,000; five barns), dietary crude protein levels were moderately reduced by on average 0.4% in grower I, grower II and finisher feeds (Treatment 2: n = 210,000; five barns).

Dietary crude protein reduction did not affect growth performance and feed conversion ratio, but decreased water intake by 4%, litter weight by 12%, and nitrogen excretions by 9% – and improved nitrogen utilisation from 61 to 63%, as well as improving footpad health.

Reducing the dietary CP with subsequent reduced nitrogen excretions could therefore be an appropriate way to help meet regulatory requirements. ■

References are available from the authors on request