Facts & Figures

Poultry No. 15178

Dietary nitrogen reduction did not compromise performance under commercial conditions but improved nitrogen balance

Conclusions

- Compared to commercial standard feeds fed to control birds (Treatment 1: n = 210,000; 5 barns), dietary crude protein levels were moderately reduced in grower I (-0.7 %-pts), grower II (-0.5 %-pts) and finisher feeds (-0.5 %-pts) (Treatment 2: n = 210,000; 5 barns).
- Dietary crude protein reduction …
  - … did not affect growth performance and feed conversion ratio.
  - … decreased water intake by 4 % and litter weight by 12 %.
  - … improved footpad health.
  - … decreased nitrogen excretions by 9 % and improved nitrogen utilization from 61 to 63 %.

Introduction and objective

In Germany, revised ordinances on fertilizing and on the management of nitrogen (**N**) and phosphorous at farm level being in force since 2017 (Ministry of Justice and Consumer Protection, 2017a,b) are expected to add pressure on the animal industry to further reduce emissions. In these documents, suggested values for the annual N-excretion per place and year are more ambitious than suggested by the Best Available Techniques Reference Document (**BAT**) by Santonja *et al*. (2017). Rough calculations based on key numbers from the current broiler feeding practice imply that it might be challenging to meet those threshold values. Consequently, farmers might be forced to run less cycles per year or reduce animals per square meter (**sqm**). Alternatively, reduction of the dietary crude protein (**CP**, N * 6.25) – as suggested in the BAT document - with subsequent reduced N-excretions could be an appropriate strategy. The present broiler feeding trial was conducted on a commercial farm as a partnership between the **University of Applied Sciences, Osnabrück, Germany,** a German feed compounder, and Evonik Nutrition & Care GmbH. Commercial diets with and without dietary N-reduction were provided to 420,000 broilers and the impact of these diets on performance, nutrient utilization and economics was evaluated.

Table 1: Experimental design including calculated crude protein (CP) levels in four feeding phases

Phase		Treatment 1 Standard CP, %	Treatment 2 N-reduced CP, %*
Starter	(d1-10)	**21.0**	
Grower I	(d11-20)	**20.2**	**19.5**
Grower II	(d21-25)	**19.6**	**19.1**
Finisher	(d26-40)	**18.6**	**18.1**

* CP: crude protein = nitrogen * 6.25

Material and Methods

A total of 420,000-day-old male and female (as hatched) Ross 308 chicken (41.0 g/chick) were allocated into 10 commercial barns with 42,000 birds each. The temperature program was in line with breeder's recommendation. At day 1 birds received 24 h light which was reduced to 22 h on days 2 and 3 and thereafter to 18 h. Broilers received a standard vaccination program against infectious bronchitis and Newcastle disease. Barns had a size of 1,800 sqm (23 birds/sqm) and were each equipped with four feeding lines and six nipple drinker lines for *ad libitum* supply of feed and water. One ton dried corn silage per barn (0.56 kg/sqm) were used as bedding and the volume was identical for each barn –no extra bedding was applied in any of the barns throughout the experiment. A 4-phase feeding program was applied comprising of a starter (d1-10), a grower I (d11-20), a grower II (d21-25), and a finisher period (d26-end). Because the first thinning crop took place at day 29, feeds free of coccidiostats were introduced already from day 26.
Wheat-corn-soybean meal-based diets were formulated according to commercial practice (Table 2). 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 (**AA**) indicated that expected values were exactly met (Table 2). Moreover, there was no variation between samples within treatment and phase. However, with respect to CP, analyzed 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 N, and there is no reason to assume that other non-protein-N affected total N. Nevertheless, analyzed N-levels were used for N-balancing calculations instead of declared N-levels. All diets contained a phytase and a xylanase, but AA-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.

Table 2: Ingredients and calculated (analyzed) nutrient composition of experimental diets

	Starter	Grower I		Grower II		Finisher	
		Treatment 1	Treatment 2	Treatment 1	Treatment 2	Treatment 1	Treatment 2
Ingredients (%)							
Wheat - unground		5.0		10.0		12.0	
Wheat	25.7	24.7	27.4	24.6	26.4	22.4	24.3
Corn	38.0	28.5		25.2		24.7	
Bakery meal		2.8				2.6	
Soybean meal	23.3	23.8	21.1	20.7	18.8	18.3	16.4
Soybean concentrate	3.0						
Rapeseed full fat	3.0	3.3		1.8		1.8	
Rapeseed expeller				1.5		1.7	
Field peas		4.8		9.0		8.8	
Vegetable oil	2.1	3.3	3.0	4.0	3.8	5.1	4.8
Lysine sulphate 70	0.63	0.33	0.46	0.29	0.38	0.28	0.37
DL-Methionine	0.40	0.33	0.35	0.30	0.31	0.28	0.29
L-Threonine	0.16	0.11	0.15	0.10	0.13	0.10	0.13
L-Valine	0.08	0.05	0.10	0.04	0.08	0.04	0.07
L-Arginine			0.08		0.06		0.06
L-Isoleucine			0.05		0.04		0.04
Minerals and Premix*	to 100	to 100	to 100	to 100	to 100	to 100	to 100
Energy (MJ AMEn/kg) and Nutrients (%)							
AMEn, MJ/kg	12.6	12.9		13.0		13.3	
Ether extract	5.9	7.1	6.9	7.3	7.1	8.4	8.1
Crude fibre	2.8	2.8	2.8	3.0	2.9	2.9	2.8
Ash	5.3	4.7	4.6	4.6	4.5	4.2	4.1
Starch	40.7	40.5	41.9	41.7	42.7	42.3	43.4
Crude protein – expected**	21.0	20.2	19.5	19.6	19.1	18.6	18.1
Crude protein - analysed**	21.6	20.6	20.1	20.1	19.9	19.3	18.8
Lysine***	1.40 (1.39)	1.20 (1.20)	1.20 (1.20)	1.17 (1.16)	1.15 (1.15)	1.09 (1.08)	1.08 (1.08)
Methionine+Cysteine**	0.99 (1.02)	0.91 (0.93)	0.89 (0.92)	0.86 (0.89)	0.88 (0.88)	0.83 (0.84)	0.82 (0.84)
Threonine**	0.89 (0.89)	0.81 (0.82)	0.81 (0.81)	0.78 (0.78)	0.78 (0.78)	0.74 (0.76)	0.74 (0.74)
Arginine**	1.34 (1.33)	1.29 (1.30)	1.30 (1.30)	1.28 (1.27)	1.29 (1.27)	1.19 (1.19)	1.20 (1.19)
Valine**	1.00 (1.02)	0.95 (0.96)	0.96 (0.96)	0.93 (0.93)	0.93 (0.92)	0.87 (0.88)	0.87 (0.87)
Isoleucine**	0.86 (0.85)	0.82 (0.82)	0.82 (0.82)	0.80 (0.79)	0.81 (0.79)	0.75 (0.75)	0.75 (0.74)
$Glycine_{equivalents}$***	1.56	1.49	1.41	1.46	1.43	1.38	1.32

* containing phytase and xylanase, starter and grower diets contained coccidiostats ** Expected values: recalculated by Evonik based on AMINODat 5.0 (for amino acids in brackets), analyzed values based on Starter feed: n=7; Grower I: n=14 / 16; Grower II: n=12 / 8; Finisher feed: n=23 / 17 for standard feed / trial feed, respectively
*** $Gly_{equivalents}$: Gly + 0.714 * Ser

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. The European Efficiency Index (**EEI**) was calculated based on biological performance (equation see Table 3). At days 29 and 34 about 24 % and 20 % of the birds were harvested leaving 56 % of the birds for the main crop during days 40, 41 and 42. With respect to the delivered live weight, the 1st, 2nd, and 3rd 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 carcass 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, N-balance and N-utilization were calculated assuming 30 g N/kg body weight (Hiller *et al*., 2014). Data were analyzed by one-way ANOVA using R-statistics "R version 3.2.2. (2016-10-31)". A barn served as experimental unit.

Table 3: Performance of 420,000 mixed-sex broiler fed commercial standard (n = 210,000) or N-reduced (n = 210,000) feeds over the entire production cycle.

	Treatment 1	Treatment 2	Pooled SEM	*P*-values
	Standard	N-reduced		
Body weights, kg/bird				
1. thinning crop, day 29	1.550	1.523	0.0316	0.366
2. thinning crop, day 34	2.016	2.004	0.0280	0.638
Main crop, days 40-42	2.789	2.780	0.0603	0.880
Overall results				
Average age, days*	36.7	36.7	0.333	0.943
Body weight – overall, kg/bird*	2.344	2.328	0.0425	0.685
Feed intake – overall, kg/bird*	3.547	3.463	0.0474	*0.083*
Feed per gain, kg/kg*	1.517	1.496	0.0144	0.138
European efficiency index**	415	419	8.7	0.611
Water and litter				
Water intake, ml/bird	7,789	7,476	135.0	**0.032**
Litter weight, t/barn	54.6	47.9	4.67	0.148
Foot pad grading* **				
Grade 0, %	86.5	97.6	6.38	*0.086*
Grade 1, %	12.1	2.3	5.45	*0.081*
Grade 2a, %	1.5	0.04	0.957	0.134
N-Balance, kg/barn				
N-Intake	4,666	4,464	57.6	**0.004**
N-Deposition****	2,852	2,810	51.9	0.393
N-Excretion	1,814	1,654	31.8	**<0.001**
N-Utilization, % of intake****	61.1	62.9	0.65	**0.014**

* weighted average including all crops ** European Efficiency Index = ([Survival rate, % * final body weight, kg] / [FCR * age, d] * 100) *** camera scoring at slaughter facility; Grade 2b not observed **** assuming 30 g N/kg final body weight (Hiller *et al*., 2014)

Results & Discussion

Performance of broilers is shown in Table 3. Final body weights both for each crop and for the overall average did not differ between treatments ($P > 0.05$). Birds in TRT 2 tended to consume less feed compared to those of TRT 1 ($P < 0.10$). However, this was not reflected in the average feed conversion ratio nor in the EEI serving as a productivity indicator ($P > 0.05$). As such, moderate reduction of dietary CP by 0.4 % in overall consumed feed did not negatively affect performance at any of the crops provided adequate supply of essential AA.

Birds in TRT 2 consumed 4 % less water ($P < 0.05$) and excreted 9 % less N ($P < 0.05$) than those in TRT 1. Metabolically, N-excretion requires water and therefore the improvement ($P < 0.05$) on N-utilization observed in birds fed lower CP levels is a good indicative of their reduced water requirements. Moreover, lower water intakes for TRT 2 birds resulted in 12 % less litter produced ($P > 0.05$). Litter moisture and ammonia content negatively impact the footpad health of broilers. In the present production cycle, there was no issue with footpad health in general. Nevertheless, birds in TRT 2 tended to have a higher incidence ($P < 0.10$) of Grade 0 and a lower incidence of Grade 1 footpads than TRT 1.

With respect to the N-balance calculations, the average moderate reduction of dietary CP by 0.4 %-points reduced N-intake by 4 % ($P < 0.05$) and N-excretions by 9 % ($P < 0.05$) in TRT 2 compared to TRT 1. Extrapolating the average reduction of dietary CP to 1 %-point would, thus, have the potential to reduce N-excretions by 22 % which is well above the 10 % suggested by Santonia *et al*. (2017). If calculated dietary CP levels were used for these calculations instead of analyzed, N-excretions would be reduced by 142 kg/barn and overall dietary N-reduction would reduce them by about 12 %. Therefore, even small reductions in the N content of broiler diets can considerably reduce N-output and therefore improve the N-balance of commercial farms.

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