Effect of dietary protein source and crude protein content on growth performance, litter quality and foot pad dermatitis in two commercial turkey strains

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INTRODUCTION

Foot pad dermatitis (FPD) is ubiquitous in commercial turkeys and is associated primarily with wet litter. Despite the large amount of work which has been conducted on foot pad dermatitis in broiler chickens, there is less information on FPD in turkeys. Results obtained in broilers may not be extrapolated to turkeys. The sector recommended a collective approach to start a comprehensive research project to study foot pad dermatitis in commercial turkeys. Therefore the ERA-NET project TURKEYWELFARE was started in 2014 with participating research institutes and industries from Italy, UK and The Netherlands.

Footpad dermatitis in turkeys is very common in commercial turkey flocks and is a potential economic and welfare problem in intensive production systems (Berg, 1998). The cause of FPD is complex and many contributing factors have been suggested such as diet composition, skin structure, bird weight, sex, strain, litter moisture and litter type. Litter quality is affected by many other factors such as stocking density, air temperature and humidity, ventilation, season, consistency and amount of excreta, and drinker design (Veldkamp, 2011). Wet droppings and subsequently wet litter may be affected by diet composition. A relation between litter quality and FPD has been demonstrated in the literature (Martland et al., 1984; 1985; Mayne et al., 2007; Wu and Hocking, 2011; Hocking and Wu, 2013). Weber Wyneken et al. (2015) observed a linear relationship between FPD and litter moisture above a breakpoint of 49% litter moisture. All factors which will cause wet and caked litter are a risk factor for FPD.

Dietary Protein Source

Feed compounders are working according to international standards concerning nutrient requirements, however the availability and costs of feedstuffs to meet these nutrient requirements vary. Certain feedstuffs, such as soya bean meal, contain high levels of potassium which adversely affect the consistency of the excreta. High dietary sodium and potassium contents may result in excessive water intake resulting in wet litter. The high potassium content in soya bean meal and the oligosaccharide content is thought to yield excreta that can contribute to FPD in turkeys. Use of other vegetable protein sources selected for lower K contents compared to soya bean meal may result in a lower dietary electrolyte balance (EB) and may improve litter quality and subsequently quality of foot pads.

Crude Protein Content

Diets with high crude protein (CP) contents also may cause an increase in water intake and wet litter as the surplus of nitrogen that is not accreted in the body has to be excreted. This process requires extra water, increase in the water/feed ratio and results in wet litter. Lowering the crude protein content in diets in combination with supplementation of free amino acids may decrease the moisture content in excreta and litter and subsequently may result in a lower incidence and severity of FPD in turkeys.

Turkey Strain

Hocking and Wu (2013) concluded that heavier lines of turkeys had higher mean FPD scores that developed earlier, than those in a traditional line, but the effect was relatively small in young turkeys.

The objective of the current study was to evaluate the effect of dietary protein source and crude protein content

on growth performance, litter quality and foot pad dermatitis in two commercial turkey strains in the period from 0 to 134 days of age.

MATERIALS AND METHODS

The experiment was conducted from 0 to 134 days of age. The experimental treatments were evaluated in a 2x2x2 factorial block design. A turkey open-sided barn of 96 x 12.3 meters was used for the experiment. The pens were located in 2 rows of 32 pens (3 m wide and 4 m deep) with 30 birds per pen (density 2.5 turkeys per m^2). In total, 1920 male turkeys (960 genotype A and 960 genotype B) were used in the study.

Feed was provided according to a five phase feeding programme in four-week phases. Four experimental diets per feeding phase were provided to two commercial turkey strains according to Table 1.

Table 1. Experimental treatments

Treatment	Crude protein content (g/kg)					Electrolyte balance (mEq/kg)	Turkey strain
Code	Phase I	Phase II	Phase III	Phase IV	Phase V		
HCP-HEB-A	290	270	230	200	175	240	A
LCP-HEB-A	260	240	200	170	145	240	A
HCP-LEB-A	290	270	230	200	175	130	A
LCP-LEB-A	260	240	200	170	145	130	A
HCP-HEB-B	290	270	230	200	175	240	B
LCP-HEB-B	260	240	200	170	145	240	B
HCP-LEB-B	290	270	230	200	175	130	B
LCP-LEB-B	260	240	200	170	145	130	B

HCP = high crude protein, LCP = low crude protein, HEB = high electrolyte balance, LEB = low electrolyte balance.

Diets were formulated isocaloric for 5 phases (0-28, 28-56, 56-84, 84-112 and 112-134 days of age) and containing per phase 290 vs. 260, 270 vs. 240, 230 vs. 200, 200 vs. 170, 175 vs. 145 g CP/kg, respectively; and EB (240 vs. 130 mEq/kg) in all phases. Free amino acids (L-Lysine HCl, DL-Methionine, L-Threonine, L-Tryptophan and L-Arginine) were supplemented to the diets according to breeder recommendations to meet the birds' digestible amino acid requirements. Diets with a low electrolyte balance (LEB) were formulated by exchange of soya bean meal by maize gluten meal, peas, potato protein, rapeseed meal and sunflower seed meal. Salt, sodium-bicarbonate and potassium-bicarbonate were used for adjusting EB levels in the experimental diets. Diets were provided as 2.3 mm pellets (0-28 days of age), 3.0 mm pellets (28-56 days of age) and 4.0 mm pellets (56-134 days of age). Water and feed were provided ad libitum.

Body weight, feed intake, and FPD scores were recorded at 28, 56 84, 112 and 134 days of age. Friability and wetness of litter were scored visually at 56, 84, 112 and 134 days of age.

RESULTS AND DISCUSSION

Body weight of turkeys fed on HP diets was significantly higher at 28 days of age than on LP diets (1107 vs. 1080 g; P<0.001). Body weight of turkeys fed on HP diets was numerically higher at 134 days of age than on LP diets, however the difference was not significant. Crude protein content did not affect daily feed intake. Feed conversion ratio of turkeys fed on HP diets was significantly lower than that of turkeys fed on LP diets (2.50 vs. 2.56; P=0.002). However, a significant interaction between CP and EB was observed for FCR (P=0.042). The effect of CP on FCR was more pronounced in turkeys fed on HEB than LEB. In the HEB treatment, the FCR of turkeys fed on HP diets was lower than FCR of turkeys fed on LP diets (2.48 vs. 2.57). In the LEB treatment, feed conversion ratio was not affected by CP treatment. In diets of the HEB treatment soya bean meal was included whereas in diets of the LEB treatment soya bean meal was exchanged by maize gluten meal, peas, potato protein, rapeseed meal and sunflower seed meal. Free amino acids (lysine, methionine, threonine, tryptophan and arginine) were supplemented to the diets according to breeder recommendations but in HEB (soya bean meal diets) other amino acids (such as valine) were possibly limiting in LP compared with HP diets. High electrolyte balance (HEB) in diets resulted in a significantly higher feed intake and body weight gain than low electrolyte balance (LEB) (feed intake was 435 vs. 420 g; P<0.001, body weight gain 172 vs. 166; P<0.001). Feed conversion ratio was not affected by EB treatment. Strain did not affect growth performance.

Table 2. Growth performance in the period from 28 to 134 days of age

CP	EB	BREED	BW 28 d (g)	BW 134 d (g)	daily BW gain (g/d)	daily FI (g/d)	FCR	Mortality (%)
HIGH			1107 ^{b}	19061	169	424	2.50 ^{a}	6.3
LOW			1080 ^{a}	18932	168	431	2.56 ^{b}	7.2
	HIGH		1164 ^{b}	19405 ^{b}	172 ^{b}	435 ^{b}	2.53	6.1
	LOW		1023 ^{a}	18588 ^{a}	166 ^{a}	420 ^{a}	2.53	7.4
		A	1130 ^{b}	19084	169	430	2.54	7.1
		B	1057 ^{a}	18910	168	425	2.52	6.4
HIGH	HIGH		1164 ^{c}	19515	173	430	2.48 ^{a}	6.1
LOW	HIGH		1164 ^{c}	19296	171	440	2.57 ^{c}	6.1
HIGH	LOW		1051 ^{b}	18608	166	418	2.52 ^{ab}	6.4
LOW	LOW		996 ^{a}	18568	166	422	2.54 ^{bc}	8.4
SOURCE OF VARIATION								
CP			**<.001**	0.235	0.336	0.053	**0.002**	0.663
EB			**<.001**	**<.001**	**<.001**	**<.001**	0.762	0.108
BREED			**<.001**	0.112	0.340	0.143	0.382	0.593
CP.EB			**<.001**	0.410	0.268	0.369	**0.042**	0.305

^{a,b,c} values in the same column with no common superscript differ significantly at P<0.05.

CP = dietary crude protein content, EB = dietary electrolyte balance, BW = body weight, FI = feed intake.

Table 3. Visual scores of friability and wetness of litter

			Friability				Wetness			
CP	EB	BREED	day 56	day 84	day 112	day 134	day 56	day 84	day 112	day 134
HIGH			8.7	5.6	4.4	4.2 [b]	4.8	4.3 [(a)]	3.8	3.8 [b]
LOW			8.7	6.0	4.3	3.8 [a]	4.9	4.7 [(b)]	3.6	3.5 [a]
	HIGH		8.2 [a]	5.4 [a]	4.2 [a]	3.8 [(a)]	4.3 [a]	4.1 [a]	3.4 [a]	3.4 [a]
	LOW		9.2 [b]	6.3 [b]	4.5 [b]	4.1 [(b)]	5.5 [b]	4.9 [b]	3.9 [b]	3.9 [b]
		A	8.6	5.9	4.4	3.9	4.9	4.5	3.8	3.7
		B	8.8	5.7	4.3	4.0	4.9	4.5	3.6	3.7
HIGH	HIGH		8.1	5.3	4.4 [b]	4.3 [b]	4.3	3.9	3.6 [(b)]	3.8 [b]
LOW	HIGH		8.3	5.4	4.0 [a]	3.4 [a]	4.4	4.2	3.3 [(a)]	3.1 [a]
HIGH	LOW		9.3	5.9	4.4 [b]	4.0 [b]	5.4	4.6	3.9 [(b)]	3.9 [b]
LOW	LOW		9.1	6.6	4.6 [b]	4.1 [b]	5.5	5.3	4.0 [(b)]	3.9 [b]
SOURCE OF VARIATION										
CP			1.00	0.107	0.457	**0.003**	0.494	0.053	0.341	**0.022**
EB			**<.001**	**<.001**	**0.008**	0.097	**<.001**	**<.001**	**<.001**	**<.001**
BREED			0.242	0.280	0.218	0.810	0.819	0.778	0.156	0.639
CP.EB			0.242	0.280	**0.029**	**<.001**	0.819	0.399	0.060	**0.022**

[a,b] values in the same column with no common superscript differ significantly at P<0.05.

Friability (score 1 = complete caked litter, score 10 = no caked litter particles).

Wetness (score 1 = wet litter, total area by pressure on the litter water is appearing, score 10 = dry litter, only observed at start).

CP = dietary crude protein content, EB = dietary electrolyte balance.

Friability of litter in pens with turkeys fed on HP diets was higher than in pens with turkeys fed on LP diets at 134 days of age. In the period until 112 days of age friability was not affected by CP. Wetness of litter in pens with turkeys fed on HP diets tended to be lower than in pens with turkeys fed on LP diets and at 134 days of age the opposite effect was observed. Effects of CP on friability and wetness were not consistent during the production period. Friability and wetness of litter in pens with turkeys fed on HEB diets were lower than in pens with turkeys fed on LEB diets during the entire production period. This means that litter in pens with turkeys fed on HEB diets (including soya bean meal; 240 mEq/kg) was more caked and wetter than litter in pens with turkeys fed on LEB diets (non-soya bean meal; 130 mEq/kg). These consistent effects of EB on wetness of the litter were also confirmed by lab analyses on litter moisture. The higher potassium content in HEB diets may have resulted in a higher water intake (water intake could not be measured in the facility) and a higher moisture content in excreta resulting in wet litter.

Table 4. Mean scores for foot pad dermatitis

			day 27	day 56	day 84	day 112	day 134
CP	EB	BREED					
HIGH			0.36 [b]	0.81 [b]	1.58 [b]	2.40	3.06
LOW			0.14 [a]	0.59 [a]	1.35 [a]	2.45	3.09
	HIGH		0.38 [b]	0.97 [b]	1.66 [b]	2.45	3.24 [b]
	LOW		0.12 [a]	0.43 [a]	1.27 [a]	2.39	2.92 [a]
		A	0.29 [b]	0.70	1.45	2.39	3.01
		B	0.21 [a]	0.70	1.47	2.45	3.15
SOURCE OF VARIATION							
CP			**<.001**	**<.001**	**<.001**	0.499	0.760
EB			**<.001**	**<.001**	**<.001**	0.379	**<.001**
BREED			**0.020**	0.966	0.703	0.399	0.114

[a,b] values in the same column with no common superscript differ significantly at P<0.05.

CP = dietary crude protein content, EB = dietary electrolyte balance.

Mean scores of foot pad dermatitis in turkeys fed on HP diets were significantly higher (P<0.001) than in turkeys fed on LP diets at 27, 56 and 84 d of age. The FPD score in turkeys fed on HEB diets was significantly higher (P<0.001) than in turkeys fed on LEB diets at 27, 56, 84 and 134 d of age. The FPD score of A strain turkeys was significantly higher (P=0.020) than the FPD score of B strain turkeys at 27 d of age. After 27 days of age no significant effect of turkey strain on FPD was observed.

SUMMARY

The objective of the study was to evaluate the effect of decreasing dietary electrolyte balance EB (high EB (HEB) vs. low EB (LEB)) and crude protein CP (high CP (HP) and low CP (LP)) in two turkey strains on growth performance, litter quality and FPD. The experimental treatments were evaluated in a 2x2x2 factorial block design. Diets were formulated to be isocaloric for 5 phases (0-28, 28-56, 56-84, 84-112 and 112-134 days of age) and containing per phase 290 vs. 260, 270 vs. 240, 230 vs. 200, 200 vs. 170, 170 vs. 140 g CP/kg, respectively; and EB (240 vs. 130 mEq/kg) in all phases. Free amino acids were supplemented to the diets according to breeder recommendations. LEB diets were formulated by exchange of soya bean meal by maize gluten meal, peas, potato protein, rapeseed meal and sunflower seed meal. Water and feed were provided ad libitum. Body weight, feed intake, and FPD were recorded at 28, 56, 84, 112 and 134 weeks of age. Overall results indicate that daily feed intake in turkeys fed on LP was numerically higher than on HP diets. Body weight gain was not affected by CP and FCR was significantly higher in turkeys fed on LP diets than in turkeys fed on HP diets (2.56 vs. 2.50; P=0.002). FPD in turkeys fed on LP diets was significantly lower

than FPD in turkeys fed on HP diets until 84 days (P<0.001). Turkeys fed on LEB diets showed a significantly lower feed intake (420 vs. 435 g/d) and body weight gain (166 vs. 172 g/d) over the period 28 to 134 days of age and a lower body weight (18588 vs. 19405 g) at 134 days of age compared with turkeys fed on HEB diets. Feed conversion ratio was not affected by EB. Litter was significantly dryer in pens with turkeys fed on LEB diets than in pens with turkeys fed on HEB diets (P<0.001). FPD in turkeys fed on LEB diets was significantly lower than in turkeys fed on HEB diets (P<0.001). FPD was not affected by turkey strain.

It is concluded that litter quality can be improved and FPD can be decreased in turkeys fed on diets containing lower CP and EB levels.

REFERENCES

Berg, C.C. 1998. Foot-Pad Dermatitis in Broilers and Turkeys Prevalence, risk factors and prevention. Doctoral thesis Swedish University of Agricultural Sciences Uppsala, Sweden.

Hocking, P.M., Wu, K. 2013. Traditional and commercial turkeys show similar susceptibility to foot pad dermatitis and behavioural evidence of pain. British Poultry Science 54(3): 281-288.

Martland, M.F. 1984. Wet litter as a cause of plantar pododermatitis leading to foot ulceration and lameness in fattening turkeys. Avian Pathology 13: 241–252.

Martland, M.F. 1985. Ulcerative dermatitis in broiler chickens: the effects of wet litter. Avian Pathology 14: 353–364.

Mayne, R.K., Else, R.W., Hocking, P.M. 2007. High litter moisture alone is sufficient to cause footpad dermatitis in growing turkeys. British Poultry Science 48: 538–545.

Veldkamp, T. 2011. Factors affecting foot pad dermatitis in broilers and turkeys. In: Proceedings of Symposium: DSM Poultry Tour - Towards a bright & sustainable poultry production, 12 April 2011, Birmingham, UK.

Wu, K., Hocking, P.M. 2011. Turkeys are equally susceptible to foot pad dermatitis from 1 to 10 weeks of age and foot pad scores were minimized when litter moisture was less than 30%. Poultry Science 90: 1170–1178.

Sulfur containing amino acids – first limiting amino acids in turkeys

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Metabolic function methionine

Amino acids are characterized by the carboxyl- and amino-group plus a substituent defining the kind of amino acid (e.g. a ring structure for tryptophan or sulfur molecules for methionine and cysteine). Binding of two amino acids happens between the carboxyl- and the amino-group under splitting of a water molecule. The row of amino acids within such a chain is depending on the protein, which is synthesized. However, the first amino acid of such a chain is always methionine (Met) since the genetic code for methionine is at the same time the start codon for the mRNA translation. This is the first important role of Met within the metabolism: protein synthesis and therefore impact on maintenance and growth. Furthermore, Met is inevitable for the formation of the co-enzyme S-adenosylmethionine (SAM) which is a methyl donor e.g. for the synthesis of polyamines, such as spermine and spermidine, and creatine. SAM is also involved in biosynthesis of hormones like epinephrine (mood control); it is required for cellular growth and repair as well as for RNA translation. Additionally Met is a precursor of important intermediates in metabolic pathways such as cystine (Cys) and carnitine, which is important for the transport of fatty acids (lipid breakdown and energy metabolism). Cys is a precursor of the antioxidant glutathione and taurine (immune response). In poultry, Met is additionally of high importance for the support of feather growth.

Methionine and cystine – requirement and supply

Gramzow (2001) investigated the ideal protein of heavy male turkeys. Wherefore the deposition of protein and single amino acids in body and feathers of a modern turkey strain (BUT Big 6 with 14 kg body weight at week 15) was determined. Figure 1 shows results for body weight and breast meat development as well as protein, lysine, Met and Cys deposition of carcass and feathers.

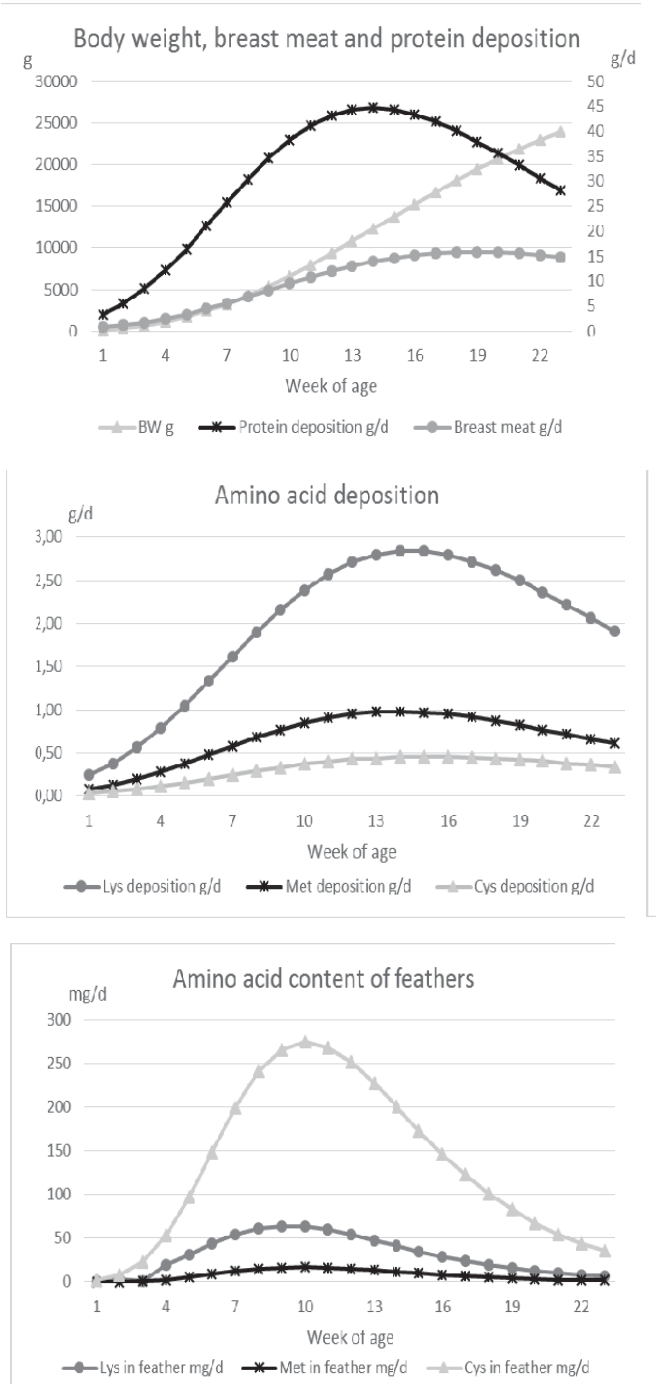

Figure 1: Body weight, breast meat and protein deposition (left), deposition of lysine, methionine and cystine (middle), and lysine, methionine and cystine content of feathers (right) of BUT Big 6 turkey toms adapted from Gramzow (2001)

The data nicely shows that within the more evenly increasing body weight, protein deposition steeply increases up to week 14 to decrease smoothly from there to day of slaughter. Breast muscle development is proceeding with the highest crude protein deposition