

Effects of 25-hydroxy-cholecalciferol (Hy•D) at doses from 35 to 560 µg per kg feed on the performance of broiler chickens fed a diet based on maize, wheat and soybean meal
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Abstract

The effects of 25-hydroxy-cholecalciferol (Hy•D) on the performance of broiler chickens were studied in a cage trial from day 8 to day 22. The birds were fed a basal diet based on maize, wheat and soybean meal supplemented with 35, 70, 140, 280 and 560 µg 25-OH-D₃ per kg, respectively. Even at the highest dose-level, performance of the chickens was not negatively affected. Weight gain was dose-dependent improved up to an inclusion level of 280 µg 25-OH-D₃ per kg feed. Feed conversion was numerically improved by about 5 % at the three highest inclusion levels. Apparent P-utilisation and concentration of tibia ash showed significant ($p < 0.05$) increases with increased dietary 25-OH-D₃ content in the feed. Tibia strength was numerically improved by the supplementation of 25-hydroxy-cholecalciferol. The highest tibia strength was found at the highest inclusion level.

Introduction

The aim of the present trial was to study the effects of Hy•D (25-OH-D₃), a metabolite of Vitamin D₃, at different doses, particularly at higher than the recommended dietary inclusion level (69 µg/kg), on the performance of broiler chickens fed a diet based on maize, wheat and soybean meal. The animals received feed supplemented from a low dose of 35 up to a high dose of 560 µg 25-OH-D₃ per kg.

Materials and Methods

On day 8 male broiler chickens (Ross PM3) were divided by weight into groups of 8 birds, which were allocated to one of the different treatments supplemented with 35, 70, 140, 280 and 560 µg 25-OH-D₃ (Hy•D[®] Beadlet 1.25 %) per kg, respectively. The chickens were housed in wire-floored battery cages. Feed and tap water were provided *ad libitum*. Each treatment was replicated with 6 groups. The experimental diet was based on maize (30%), wheat (26%) and soybean meal (37 %) and contained 222 g crude protein, 12.7 MJ ME_N, 7.6 g total phosphorus (P), and 11.1 g calcium (Ca) per kg feed. No additional Vitamin D₃ was supplemented to the basal diet. The feed was pelleted (3 x 20 mm) at 70°C. 25-OH vitamin D₃ was determined by a HPLC connected with a mass-selective detector (MSD) after clean up of a crude extract with a semi-preparative HPLC (Hofmann et al. 2003). From day 14 to day 17, the excreta from 4 selected groups of chickens per treatment were collected quantitatively once per day. The content of dry matter, crude ash, phosphorus and calcium was determined. On day 22 blood samples were taken from v. jugularis. The blood plasma concentrations of 25-hydroxy-cholecalciferol were determined (Gössl et al. 2004). The chickens were sacrificed, dissected and the right tibia of the chickens was removed. A segment of the central portion of the bone shaft (about 2 cm long) was prepared. A LR10K compression machine with a XLC/10K/A1 force captor and a compression device TH23-196/AL (Lloyd Instruments, Fareham, UK) was used to determine the force (in Newton) necessary to break the bone. The broken bones were pooled per cage, defatted with ethanol and ether, dried and incinerated at 550°C. The ash content was determined (VDLUFA

1976). For the statistical evaluation a one-factorial analysis of variance (factor: treatment) was carried out. Where significant treatment effects ($p < 0.05$) were indicated, the differences among treatment means were analyzed with the Newman-Keuls test.

Results and Discussion

Table 1 shows the determined product contents in feed. In general there was a recovery found of about 75 %. The concentrations of 25-OH-D₃ in the plasma were significantly increased in a clear dose-dependent manner (Table 2).

The results of the growth performance of the broiler chickens from day 8 to day 22 are shown in Table 3. Weight gain was numerically improved from the treatment with 35 to the treatment with 280 μg 25-OH-D₃/kg. A significant difference between treatment A (35 μg 25-OH-D₃/kg) and D (280 μg 25-OH-D₃/kg) was noted. Treatment E (560 μg 25-OH-D₃/kg) showed comparable results to treatment A. Feed intake was not significantly influenced by the supplementation of 25-OH-D₃. Feed conversion was numerically improved by the supplementation of 25-OH-D₃ by 2.6 % for treatment B up to 5.2 % for treatment D. Treatment E showed a numerical improvement of 4.7 % compared to treatment A.

Table 4 shows the apparent utilisation of phosphorus and calcium based on four days of balance period (days 14 to 17). Apparent P-utilisation was improved by the supplementation of 25-OH-D₃. A significant improvement of about 6 % was obtained by the inclusion levels of 280 and of 560 μg 25-OH-D₃ per kg feed. The apparent calcium utilisation was numerically improved in treatments B, D and E by about 5 % compared to treatment A.

Tibia strength (Table 6) was numerically improved by the supplementation of 25-hydroxy-cholecalciferol. The highest tibia strength was found at the highest inclusion level. Because of the high variation within the groups, these differences were not significant, whereas tibia ash, as a parameter for bone mineralization, was significantly improved up to 2.4 % at the dose of 560 μg 25-OH-D₃ per kg feed.

Conclusion

It can be concluded, that even high inclusion levels of 560 μg 25-OH-D₃ per kg feed did not negatively affect the performance of the chickens. Weight gain from day 8 to day 22 was dose-dependent improved up to an inclusion level of 280 μg 25-OH-D₃ per kg feed. Apparent P-utilisation and concentration of tibia ash showed significant ($p < 0.05$) improvement with increased dietary 25-OH-D₃ content in the feed. Feed conversion was numerically improved at higher doses of 25-OH-D₃.

Table 1: Analyzed product concentrations in samples of the experimental diets

<i>Treatment</i>	25-OH-D ₃ ($\mu\text{g}/\text{kg}$) dosed	25-OH-D ₃ ($\mu\text{g}/\text{kg}$) analyzed
A	35	24.7
B	70	44.1
C	140	105
D	280	205
E	560	374

Table 2: Concentrations of 25-hydroxy-cholecalciferol in the plasma of male broiler chickens, mean \pm S.D.

Product	Hy•D (25-OH-D ₃)				
	A	B	C	D	E
Treatment					
Dose ($\mu\text{g}/\text{kg}$)	35	70	140	280	560
25-Hydroxy-cholecalciferol (ng/ml)	24.8 ^E \pm 3.62	53.5 ^D \pm 3.50	84.8 ^C \pm 6.95	155 ^B \pm 19.5	250 ^A \pm 36.1

Means within a row, not sharing a common superscript, are significantly different ($p < 0.05$)

Table 3: Performance of broiler chickens (day 8 to day 22), mean ± S.D.

Product Treatment Dose (µg/kg)	Hy•D (25-OH-D ₃)				
	A 35	B 70	C 140	D 280	E 560
Weight gain (g/bird)	829 ^B ± 26	846 ^{AB} ± 24	865 ^{AB} ± 32	881 ^A ± 33	826 ^B ± 25
%	100.0	102.1	104.4	106.3	99.7
Feed intake (g/bird)	1162 ^A ± 62	1156 ^A ± 25	1153 ^A ± 60	1171 ^A ± 66	1105 ^A ± 94
%	100.0	99.5	99.2	100.7	95.1
FCR (g feed/g gain)	1.403 ^A ± 0.079	1.367 ^A ± 0.016	1.333 ^A ± 0.076	1.330 ^A ± 0.077	1.337 ^A ± 0.093
%	100.0	97.4	95.0	94.8	95.3
Mortality (%)	2.1	6.3	0.0	0.0	2.1

Means within a row, not sharing a common superscript, are significantly different (p<0.05)

Table 4: Apparent utilisation (% of intake) of phosphorus and calcium of selected broiler chickens, 4 days of balance period (days 14 to 17), n = 4 groups per treatment, mean ± S.D.

Product Treatment Dose (µg/kg)	Hy•D (25-OH-D ₃)				
	A 35	B 70	C 140	D 280	E 560
Apparent P-utilisation	48.0 ^B ± 0.68	49.1 ^{AB} ± 2.00	49.2 ^{AB} ± 1.20	51.2 ^A ± 1.51	51.0 ^A ± 1.33
%	100.0	102.2	102.4	106.6	106.2
Apparent Ca-utilisation	38.8 ^A ± 1.79	40.9 ^A ± 2.97	39.1 ^A ± 1.45	40.6 ^A ± 1.93	40.7 ^A ± 1.67
%	100.0	105.5	100.8	104.8	104.9

Means within a row, not sharing a common superscript, are significantly different (p<0.05)

Table 5: Tibia strength (Newton at breaking point) and tibia ash of broiler chickens at day 22, mean ± S.D.

Product Treatment Dose (µg/kg)	Hy•D (25-OH-D ₃)				
	A 35	B 70	C 140	D 280	E 560
Tibia strength (N)	292 ^A ± 26	324 ^A ± 41	331 ^A ± 28	303 ^A ± 31	341 ^A ± 23
%	100.0	111.1	113.5	103.7	116.9
Tibia ash (% of DM)	53.8 ^C ± 0.2	54.4 ^B ± 0.3	54.7 ^{AB} ± 0.3	54.6 ^{AB} ± 0.5	55.1 ^A ± 0.4
%	100.0	101.0	101.7	101.5	102.4

Means within a row, not sharing a common superscript, are significantly different (p<0.05)

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