Feed supplementation effect of 25-hydroxycholecalciferol and canthaxanthin in broiler breeders and their progeny

Elisa Folegatti and Mustafa Unal
DSM Nutritional Products

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Vitamins and antioxidants supplementation via maternal transfer

- Maternal transfer of nutrients to the embryo
- Importance of the vitelline membrane status
- Breeders performance → Broiler performance
Metabolism of Vitamin D₃

**Feed**

Vitamin D₃

**Skin**

UVB irradiation

7-dehydrocholesterol

Vitamin D₃

**Liver**

HYDROXYLATION

25-OH-D₃

In the liver Vitamin D₃ is hydroxylated to 25OHD₃ by the action of 25 hydroxylase, a non-specific and non-regulated enzyme. In hens suffering from liver disorder (fatty liver) the conversion is impaired.

**Gut**

ABSORPTION

D₃

Absorbed by passive diffusion and with the intervention of lipase and bile acids, as for fats, by forming micelles. In birds lack of lipase in first 10 days limits vitamin D absorption. Also enteric disorders prevent the absorption and utilization of vitamin D.

**Kidney**

1,25-OH₂-D₃

In hens suffering from liver disorder (fatty liver) the conversion is impaired.

The conversion of 7-dehydrocholesterol to vitamin D₃ in the skin is highly depending on the farm system and on the hens attitude (laying down or standing).
Metabolism of 25OHD₃

- **Skin**: Vitamin D₃ synthesis from 7-dehydrocholesterol through UVB irradiation is not needed.
- **Liver**: 25OHD₃ hydroxylation is not needed.
- **Kidney**: 1,25-OH₂-D₃ production is needed.
- **Gut**: 25OHD₃ absorption is less dependent on fat digestion because of the higher polarity of the molecule and is not dependent on bile availability and fat absorption. Good absorption also in case of malabsorption syndrome.
During the first days the embryo is protected by the vitelline membrane

**The vitelline membrane**
- protects the embryo (pH 6) from the high pH of the albumen (pH 9.4)
- If too weak the embryo will die resulting in higher early embryo mortality

1-day embryo

**The embryo**
- progressively gets surrounded by the yolk sac
- is totally protected in the yolk sac between the 3 and 4 days of incubation
- during this period, the main generation of ROS is inside the yolk

3/4-days embryo

Canthaxanthin is the only source of antioxidants that has the whole activities and is deposited in the yolk to protect the membrane
Objective of trial 1 and 2

Evaluate the effect of a dietary supplementation with 25-hydroxycholecalciferol and canthaxanthin on broiler breeders and on the performance of their progeny
Material & Methods

Trial 1

BREEDERS
Birds: 80 broiler breeders Cobb 500 (40 birds/treatment) reared from 25 to 62 weeks in a floor pen facility
Treatment
Control: Vitamin D\textsubscript{3}
25OHD\textsubscript{3}+CTX: 25-hydroxy-D\textsubscript{3}+ canthaxanthin
Measurements: egg production, fertility and hatchability

BROILERS
Birds and treatments: 300 chicks (75 birds/treatment) were placed into 20 pens in a 2x2 factorial design → breeders fed or not 25-hydroxy-D\textsubscript{3}+ canthaxanthin and progeny fed or not 25-hydroxy-D\textsubscript{3}+ canthaxanthin until 21 days of age.
Measurements: farm performance and slaughterhouse yields.
All data were analyzed by software SAS (Cary, NC).

Araujo et al., 2014
Results - trial 1

Breeders performance

Performance parameters evaluated in breeders fed a Control diet (Vit. D₃) and a diet supplemented with 25OHD₃ and CTX (25-hydroxy-D₃ and canthaxanthin) at 35, 45 and 62 weeks.

Araujo et al., 2014

P<0.05
Results - trial 1
Broilers performance

Body weight measured at 42 days in broilers hatched from breeders fed a Control diet (Vit. D₃) and a diet supplemented with 25OHD₃ and CTX (25-hydroxy-D₃ and canthaxanthin) at 35, 45 and 62 weeks.

Body weight (kg) at 42 days

<table>
<thead>
<tr>
<th></th>
<th>35 weeks</th>
<th>45 weeks</th>
<th>62 weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control breeders</td>
<td>2.857</td>
<td>2.873</td>
<td>2.830</td>
</tr>
<tr>
<td>25OHD₃ + CTX breeders</td>
<td>2.864</td>
<td>2.862</td>
<td>2.945</td>
</tr>
<tr>
<td>Control progeny</td>
<td>2.913</td>
<td>2.947</td>
<td>2.989</td>
</tr>
<tr>
<td>25OHD₃ + CTX progeny</td>
<td>2.981</td>
<td>2.994</td>
<td>2.945</td>
</tr>
</tbody>
</table>

P<0.05

Araujo et al., 2014
Results - trial 1

Broilers performance

Carcass yield measured at 42 days in broilers hatched from breeders fed a Control diet (Vit. D₃) and a diet supplemented with 25OHD₃ and CTX (25-hydroxy-D₃ and canthaxanthin) at 35, 45 and 62 weeks.

Control breeders
25OHD₃ + CTX breeders

35 weeks
69.60 70.33
45 weeks
70.14 71.22
62 weeks
70.04 72.23

Carcass yield, %

P<0.05

Araujo et al., 2014
Material & Methods

Trial 2

MATERNAL TREATMENT

Eggs: 358 eggs from Ross PM3 were hatched in INRA facility.

Treatments
Control: Vitamin D₃
25OHD₃+CTX: 25-hydroxy-D₃+ canthaxanthin

Measurements: fertility and hatchability of the incubated eggs

BROILERS

Birds and treatments: At hatch and at day 6, 12 chicks/treatment (Control = Vit. D₃; 25OHD₃ = 25-hydroxy-D₃) were sacrificed and the *P. mayor* muscle were dissected.

Measurements: the level of gene expression was evaluated by real time PCR following reverse transcription.

The analysis of variance were performed using GLM procedure of SAS. Data on body weight, muscle growth and gene expression were further analysed by PCA using the SPAD8 software

Berri et al., 2015
Results - trial 2
Gene expression measured in DOC

Relative gene expression levels measured by real time RT-PCR in the Pectoralis major muscle of day old chicks hatched from breeders fed either a Control (Vit. D3) or a 25OHD3+CTX (25-hydroxy-D3 and canthaxanthin) diet

<table>
<thead>
<tr>
<th>Gene</th>
<th>Control</th>
<th>25OHD3 + CTX</th>
<th>Origin effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>VDR</td>
<td>0.66 ± 0.18</td>
<td>0.95 ± 0.16</td>
<td>0.24</td>
</tr>
<tr>
<td>RXR</td>
<td>0.84 ± 0.08</td>
<td>0.76 ± 0.08</td>
<td>0.48</td>
</tr>
<tr>
<td>MyoD</td>
<td>1.38 ± 0.14</td>
<td>1.62 ± 0.14</td>
<td>0.22</td>
</tr>
<tr>
<td>Myf5</td>
<td>1.20 ± 0.19</td>
<td>1.40 ± 0.19</td>
<td>0.48</td>
</tr>
<tr>
<td>Myogenin</td>
<td>0.35 ± 0.05</td>
<td>0.45 ± 0.05</td>
<td>0.18</td>
</tr>
<tr>
<td>PAX7</td>
<td>1.47 ± 0.09</td>
<td>1.62 ± 0.09</td>
<td>0.26</td>
</tr>
<tr>
<td>PCNA</td>
<td>1.06 ± 0.11</td>
<td>1.26 ± 0.11</td>
<td>0.20</td>
</tr>
<tr>
<td>IGF-1</td>
<td>0.43 ± 0.06</td>
<td>0.60 ± 0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>MyHC embryonic</td>
<td>1.35 ± 0.20</td>
<td>1.72 ± 0.2</td>
<td>0.20</td>
</tr>
<tr>
<td>MyHC neonatal</td>
<td>0.08 ± 0.02</td>
<td>0.11 ± 0.02</td>
<td>0.23</td>
</tr>
<tr>
<td>MyHC adult</td>
<td>0.011 ± 0.002</td>
<td>0.017 ± 0.002</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Berri et al., 2015
Results - trial 2
Principal Component Analysis (day 6)

Providing 25-hydroxy-D₃ in the broilers diet stimulate muscle growth

Providing 25-hydroxy-D₃ and canthaxanthin in breeders diet stimulate the expression of genes involved in muscle growth and differentiation

Berri et al., 2015
Conclusions

• In both studies, the supplementation of 25-hydroxycholecalciferol and canthaxanthin enhanced the breeders performance, in particular the fertility and the hatchability rates;

• Broilers fed 25-hydroxycholecalciferol and canthaxanthin up to 21 days showed an improvements of the production parameters in term of body weight, carcass and breast meat yields;

• In the second trial, the supplementation of 25-hydroxycholecalciferol and canthaxanthin to the breeders improved the chicks performances in term of myogenic gene expression (body weight and meat yields);

• These outcomes are indicating a beneficial effect of the combination of the 25-hydroxycholecalciferol and canthaxanthin to exploit the breeders and broilers potential.
Thanks for your attention