Growth, body-fat deposition, nitrogen excretion and efficiencies of nutrients utilization in broiler-chicks fed low-protein diets supplemented with amino acids, conjugated linoleic acid or an α-glucosidase inhibitor

V. A. Aletor¹*, F. X. Roth², Brigitte R. Paulicks¹ and Dora A. Roth-Maier¹


Introduction

It is now generally recognised that intensive animal production is a major contributor to pollution of environment. Within the European Union for example, farm animal effluents have been identified as a major source of nitrate pollution of water systems. These environmental concerns regarding groundwater contamination with nitrate, phosphorus and other elements led to the issuance of a Council Directive in 1991, limiting the amount of N in slurry to be spread on farm lands. For example, in pigs or poultry about 65% of the ingested dietary-N is excreted via urine and faeces (Kirchgessner and Roth, 1993) implying that the efficiency of utilization of dietary protein by these species is only about 35–40%. One of the current approaches to reduce the risk of N pollution of the environment is via dietary manipulations involving the feeding of low-protein amino acid-supplemented diets (Aletor et al., 2000; Gruber et al., 2000). The overall principle is to ensure a more efficient dietary-N utilization by these animals by feeding them low-protein diets supplemented with essential amino acids (EAA) in better agreement with standard dietary recommendations. In an earlier report (Aletor et al., 2000) it was demonstrated that feeding low-protein diets confers potential economic advantage while the accompanying increased efficiency of dietary N-utilization lowers the amount of excretable N into the atmosphere.

However, while N-excretion was decreased by as much as 41% without affecting weight gain, a consistent observation in low-protein feeding to broilers is the substantial increase in body fat retention (deposition). The increased carcass fatness is undesirable, not only from the point of view of nutrient economy, but also product quality and human health considerations. One suggested approach to attain desirable carcass fat levels in low-protein fed broilers, relate to the dietary incorporation of conjugated linoleic acids (CLAs). The CLAs are a mixture of positional (9,11 -octadecadienoic acid) and geometric (cis and trans) isomers of linoleic acid (cis-9, cis-12-octadecadienoic acid) with only one single bond separating their double bonds (Fritsche and Steinhart, 1998) unlike linoleic acid which has its double bond separated by two single bonds. Although CLAs occur naturally in dairy products and ruminant meat, they are currently being produced industrially by alkaline isomerization. Some of the biological activities ascribed to CLAs include anti-carcinogenesis (Ha et al., 1987), immune modulation (Cooke et al., 1993), enhanced weight gain and feed efficiency (Chin et al., 1994), prevention of atherosclerosis (Lee et al., 1994), body fat reduction and body nutrient repartitioning (Pa riza et al., 1996; Park et al., 1999; Jahreis et al., 1999; Simon et al., 2000). Another dietary supplement with potential for body fat reduction is Precose (Acarbose) or Bay g 5421. Bay g 5421 contains oral α-glucosidase inhibitors currently used in the management of Type 2 diabetes mellitus in humans. It is an oligosaccharide obtained from the fermentation process of a micro-organism, Actinoplanes utahensis (Bayer, 1999) and it is chemically known as O-4,6-dideoxy{(1S,4R,5S,6S)-4,5,6-trihydroxy-3-(hydroxymethyl)-2-cyclohexen-1-yl}(a-D-glucopyranosyl-1-(4-O-α-D-glucopyranosyl-(4-O-α-D-glucopyranosyl)-D-glucose. Unlike the sulfonyleureas, this oligosaccharide does not enhance insulin secretion, but brings about anti-hyperglycaemic action by competitively and reversibly inhibiting pancreatic α-amylase and membrane-bound intestinal α-glucoside hydrolase enzymes.

Until now, there is paucity of information on studies aimed at correct for increased body fat deposition that is consistent with feeding broiler-chickens low-protein diets. The need for such studies is compelling, because in spite of the benefits to the environment of the concept of feeding low-protein, amino acid-supplemented diets, it is unlikely to command wider commercial acceptability if the problem of increased carcass fatness persists. This need forms the major basis for the design of the present study which investigates the effect of low-protein amino acid-supplemented diets in combination with the inclusion of two levels of CLAs or an α-glucosidase inhibitor, respectively.

¹ Fachgebiet Tierernährung und Ernährungswissenschaft,
² Fachgebiet Tierernährung und Leistungsp physiologie, Technische Universität München, Freising-Weihenstephan, Germany.
Materials and Methods

Experimental diets

The trial comprised six isoenergetic (13.0 MJ kg\(^{-1}\)) broiler-chick diets (D1–D6; Table 1) containing 230 (High-protein, HP – D1) or 180 g kg\(^{-1}\) (Low-protein, LP – D2) crude protein furnished by maize-soybean meal. Diets 3 and 4 were derived from the LP-diet ie, D2, by the respective supplementation of 20 or 40 g kg\(^{-1}\) CLA-enriched oil (TrofoCell Research and Trade GmbH, Hamburg) with the following composition (%): oleic acid – C\(_{18}\):1, 14.2; linoleic acid – C\(_{18}\):2, 0.4; CLAs – C\(_{18}\):2 cis-9, trans-11, 34.2; trans-10, cis-12, 34.0; other CLAs 4.0; linolenic acid – C\(_{18}\):3, 0.02; other fatty acids, 13.18. Diets 5 and 6 were also derived from from diet 2 by the respective supplementation of 50 or 100 mg kg\(^{-1}\) Bay g 5421 (Bayer AG, Wuppertal, Germany). The HP diet – D1 therefore served as the positive control while the LP diet – D2 served as the negative control. To minimize amino acid imbalances, in the HP or LP diets, the proportions of maize : soybean meal (SBM) were kept relatively constant. The amino acids in the diets were calculated, and any deficient essential amino acids (EAAs) were supplemented in crystalline form to meet the minimum (NRC, 1994) digestible amino acids requirements. The metabolizable energy (ME) and crude protein (CP) equivalents of the EAAs supplements were taken into account in the formulations as listed by NRC (1994). The CLA was added at the expense of soya oil while Bay g 5421 was at the expense of cellulose. All diets were mixed mechanically and pelleted prior to use.

### Table 1. Composition of experimental diets (g kg\(^{-1}\))

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Diets</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>D1</td>
<td>D2</td>
<td>D3</td>
<td>D4</td>
<td>D5</td>
<td>D6</td>
</tr>
<tr>
<td></td>
<td>468.79</td>
<td>324.50</td>
<td>324.50</td>
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<tr>
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<tr>
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<td>231.90</td>
<td>231.90</td>
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<tr>
<td>Cellulose</td>
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<td>52.26</td>
<td>52.26</td>
<td>52.26</td>
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<tr>
<td>Soya oil</td>
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<td>53.50</td>
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<td>Vitamin Premixa</td>
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<td>EAAs</td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>DL-Methionine</td>
<td>0.91</td>
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<td>3.01</td>
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<tr>
<td>Lysine HCl</td>
<td>–</td>
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<td>–</td>
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<td>2.37</td>
<td>2.37</td>
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<tr>
<td>Tryptophan</td>
<td>–</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
<td>0.21</td>
</tr>
<tr>
<td>Arginine</td>
<td>–</td>
<td>1.63</td>
<td>1.63</td>
<td>1.63</td>
<td>1.63</td>
<td>1.63</td>
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<tr>
<td>Valine</td>
<td>–</td>
<td>1.90</td>
<td>1.90</td>
<td>1.90</td>
<td>1.90</td>
<td>1.90</td>
</tr>
<tr>
<td>Isoleucine</td>
<td>–</td>
<td>1.42</td>
<td>1.42</td>
<td>1.42</td>
<td>1.42</td>
<td>1.42</td>
</tr>
<tr>
<td>CLA-enriched oil *</td>
<td>–</td>
<td>–</td>
<td>20.00</td>
<td>40.00</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Bay g 5421 **</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.05</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Calculated analysis:

- **Crude Protein (g kg\(^{-1}\))**: 230.0 180.0 180.0 180.0 180.0 180.0
- **ME (MJ kg\(^{-1}\))**: 13.0 13.0 13.0 13.0 13.0 13.0
- **Energy/Protein Ratio**: 57 72 72 72 72 72
- **Pure CLA Equiv. (g kg\(^{-1}\))**: – 13.6 27.3 – – –

* Supplying (per kg): Ca, 10.0 g; P, 4.5 g; Na, 2.0 g; Me, 60.0 mg; Zn, 40.0 mg; Fe, 80.0 mg; Cu, 8.0 mg; I, 0.35 mg; Se, 0.15 mg
* Supplying (per kg): Vit A, 8000 I.E; vit D3, 1000 I.E; vit E, 40.0 mg; K3, 0.5 mg; B1, 1.8 mg; B2, 3.6 mg; B6, 3.5 mg; B12, 0.01 mg; D-Biotin, 0.15 mg; Folic acid, 0.55 mg; Nicotinic acid, 35 mg; Ca-Panthotenic acid, 10.0 mg; vit C, 30 mg; Choline chloride, 1300 mg.

** CLA – Conjugated linoleic acid, ** α-GLI – glucosidase inhibitor [Bay g 5421]
Organs and carcass measurements

At the end of the trial, all chickens were fasted over-night to minimize interference from intestinal contents and then weighed. Thereafter, one chick/replicate (ie 6 chicks/group) with about the same mean group weight were sacrificed by stunning followed by cervical dislocation while avoiding the loss of blood. They were then put into labelled individual cellophane bags and kept deep-frozen at −25 °C prior to whole-body analysis. Another set of 6 chickens/diet were similarly selected, sacrificed for organs and carcass measurements. The liver, heart, pancreas, spleen and abdominal fat pad were carefully collected, blotted free of blood and weighed. In this study, abdominal fat pad is defined as the tissue surrounding the gizzard and intestines, extending within the ischium, and surrounding the cloaca and bursa of fabricius (Fancher and Jensen, 1989). Their corresponding carcass cuts of interest – breast and thigh – were similarly dissected out and weighed. In both cases, all dissections were carried out by the same person on the same day to ensure that all cuts were uniform.

Analytical procedures

Dietary protein and Amino Acids

Prior to dietary formulation, the CP of maize and soy bean (solvent extracted) were analysed by Kjeldahl method (AOAC, 1995). From the protein values, the essential amino acid values were generated using their respective regression equations (Degussa, 1999). Dry matter, ash, crude fat and crude fibre of the compounded diets (Table 2) were similarly determined (AOAC, 1995).

Analysis of whole-body

Before analysis, the frozen carcasses (including feathers) were cut into slices with an electric saw before transfer (avoiding loss of materials) into a meat mincer/homogenizer (Model DI – B. L. Eisele, Stuttgart, Germany). After thorough homogenization, about 500 g of each homogenate was dried to constant weight for about 3 days using a UNITOP 1000L freeze drier. After freeze-drying, the samples were milled with a blender prior to analysis. Nine samples were finely milled to 0.5 mm particle size and the residual moisture determined by method of AOAC (1995). The generated data were subjected to one-way analysis of variance (ANOVA) of the general linear model (GLM) using SAS (1990) statistical package. Where treatment means were significantly different, they were compared using Student-Neuman-Keul's Test (SNK).

N-excretion and nutrient retention efficiency estimates

After the chemical analyses of the diets and whole-body, the following indices of nutrient repartitioning potentials of the different supplements were estimated as follows:

\[
\text{Energy retention efficiency (\%) } = \frac{\text{MJ Energy retained } + 100}{\text{MJ Energy consumed}}
\]

\[
\text{Protein retention efficiency (\%) } = \frac{\text{g Crude protein retained } + 100}{\text{g Crude protein consumed}}
\]

\[
\text{Fat retention efficiency (\%) } = \frac{\text{g Fat retained } + 100}{\text{g Fat consumed}}
\]

\[
\text{Ash retention efficiency (\%) } = \frac{\text{g Ash retained } + 100}{\text{g Ash consumed}}
\]

\[
\text{Protein efficiency ratio (PER) } = \frac{\text{g Weight gain}}{\text{g Crude protein consumed}}
\]

\[
\text{N excretion } = \text{g N consumed } - \text{g N retained}
\]

Analysis of faecal dry matter and starch

Prior to these determinations, the freeze-dried faecal samples were finely milled to 0.5 mm particle size and the starch content of the samples were determined by the enzymatic hydrolysis method described by Brandt et al. (1987).

Data Analysis

The generated data were subjected to one-way analysis of variance (ANOVA) of the general linear model (GLM) using SAS (1990) statistical package. Where treatment means were significantly different, they were compared with Student-Neuman-Keul’s Test (SNK).

Results

Performance characteristics

Table 3 presents weight gain (WG), feed consumption (FC) and feed conversion efficiency (FCE) of the chicks. Reducing dietary CP from 230 g kg⁻¹ in D1 (ie positive control) to 180 g kg⁻¹ in D2 (ie negative control) had no significant effect on WG, FC and FCE. However, chicks fed the negative control diet consumed 9% more feed and were 6% less efficient. Similarly, CLA supplementation in the LP diet had no significant effect on WG, FC and FCE. However, chicks fed the negative control diet consumed 9% more feed and were 6% less efficient. Similarly, CLA supplementation in the LP diet had no significant effect on WG, FC and FCE. However, chicks fed the negative control diet consumed 9% more feed and were 6% less efficient. Similarly, CLA supplementation in the LP diet had no significant effect on WG, FC and FCE.
Table 3. Performance of broiler-chicks fed low-protein diets supplemented with amino acids, CLA or an α-glucosidase inhibitor

<table>
<thead>
<tr>
<th>Diets</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLA-enriched oil (g kg⁻¹)</td>
<td>–</td>
<td>–</td>
<td>20</td>
<td>40</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>α-glucosidase inhibitor (mg kg⁻¹)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Crude protein (g kg⁻¹)</td>
<td>230</td>
<td>175</td>
<td>180</td>
<td>180</td>
<td>178</td>
<td>175</td>
</tr>
<tr>
<td>Initial weight (g)</td>
<td>803</td>
<td>810</td>
<td>812</td>
<td>815</td>
<td>809</td>
<td>810</td>
</tr>
<tr>
<td></td>
<td>± 5</td>
<td>± 10</td>
<td>± 10</td>
<td>± 17</td>
<td>± 16</td>
<td>± 20</td>
</tr>
<tr>
<td>Final weight (g)</td>
<td>2566</td>
<td>2619</td>
<td>2562</td>
<td>2506</td>
<td>2476</td>
<td>2253</td>
</tr>
<tr>
<td></td>
<td>± 80</td>
<td>± 100</td>
<td>± 79</td>
<td>± 97</td>
<td>± 63</td>
<td>± 55</td>
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<tr>
<td>Weight gain (g chick⁻¹)</td>
<td>1763</td>
<td>1809</td>
<td>1750</td>
<td>1691</td>
<td>1667</td>
<td>1443</td>
</tr>
<tr>
<td></td>
<td>± 79</td>
<td>± 106</td>
<td>± 76</td>
<td>± 98</td>
<td>± 69</td>
<td>± 36</td>
</tr>
<tr>
<td>Feed consumption (g chick⁻¹)</td>
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<td>3416</td>
<td>3178</td>
<td>3171</td>
<td>3851</td>
<td>4019</td>
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<tr>
<td></td>
<td>± 220</td>
<td>± 112</td>
<td>± 225</td>
<td>± 116</td>
<td>± 204</td>
<td>± 146</td>
</tr>
<tr>
<td>Feed conversion efficiency (Feed/gain)</td>
<td>1.78</td>
<td>1.89</td>
<td>1.82</td>
<td>1.88</td>
<td>2.31</td>
<td>2.79</td>
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</table>

Means ± SD are for 6 replications per diet. Values in parenthesis are percentages relative to the positive control – D1.

Means without similar superscripts in the same row differ significantly (P ≤ 0.05).

Table 4. Relative weights (g kg⁻¹ body weight) of selected carcass cuts and organs in broiler-chicks fed supplemental CLA or an α-glucosidase inhibitor

<table>
<thead>
<tr>
<th>Diets</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLA-enriched oil (g kg⁻¹)</td>
<td>–</td>
<td>–</td>
<td>20</td>
<td>40</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>α-glucosidase inhibitor (mg kg⁻¹)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Crude protein (g kg⁻¹)</td>
<td>230</td>
<td>175</td>
<td>180</td>
<td>180</td>
<td>178</td>
<td>175</td>
</tr>
<tr>
<td>Chest</td>
<td>230.5</td>
<td>214.2</td>
<td>228.4</td>
<td>215.6</td>
<td>216.9</td>
<td>208.8</td>
</tr>
<tr>
<td></td>
<td>± 21.9</td>
<td>± 17.5</td>
<td>± 17.4</td>
<td>± 13.8</td>
<td>± 5.8</td>
<td>± 5.6</td>
</tr>
<tr>
<td>Thigh</td>
<td>54.1</td>
<td>51.5</td>
<td>54.1</td>
<td>55.4</td>
<td>53.2</td>
<td>48.7</td>
</tr>
<tr>
<td></td>
<td>± 6.4</td>
<td>± 2.3</td>
<td>± 3.3</td>
<td>± 3.0</td>
<td>± 3.0</td>
<td>± 4.3</td>
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<tr>
<td>Liver</td>
<td>20.1</td>
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<td>24.5</td>
<td>29.1</td>
<td>20.2</td>
<td>19.2</td>
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<td>± 4.4</td>
<td>± 3.3</td>
<td>± 1.9</td>
<td>± 3.5</td>
<td>± 1.3</td>
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<tr>
<td>Heart</td>
<td>5.9</td>
<td>6.5</td>
<td>5.9</td>
<td>6.1</td>
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</tr>
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<td>± 0.7</td>
<td>± 0.7</td>
<td>± 0.7</td>
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<td>± 1.0</td>
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<tr>
<td>Pancreas</td>
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<td>± 0.2</td>
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<td>Spleen</td>
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<td></td>
<td>± 0.3</td>
<td>± 0.2</td>
<td>± 0.4</td>
<td>± 0.2</td>
<td>± 0.2</td>
<td>± 0.1</td>
</tr>
<tr>
<td>Abdominal fat pad</td>
<td>10.4</td>
<td>22.2</td>
<td>22.4</td>
<td>19.4</td>
<td>11.1</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td>± 2.0</td>
<td>± 6.1</td>
<td>± 5.3</td>
<td>± 5.4</td>
<td>± 4.2</td>
<td>± 2.4</td>
</tr>
</tbody>
</table>

Means ± SD are for 6 replications per diet. Values in parenthesis are percentages relative to the positive control – D1.

Mean without similar superscripts in the same row differ significantly (P ≤ 0.05).
Means without similar superscripts in the same row differ significantly (P < 0.05).

Means without similar superscripts in the same row differ significantly (P ≤ 0.05).

Relative organ weights and carcass characteristics

The relative weights of the organs and the selected carcass cuts (g kg⁻¹ body weight) are presented in Table 4. Neither the decrease in dietary CP from 230 to 180 g kg⁻¹ nor the supplementation of either CLA or Bay g 5421 had any significant effect on relative weights of breast or thigh. However, Bay g 5421 supplementation reduced weights of carcass cuts by 9–10% in the 100 mg kg⁻¹ dose level. Of the organs weighed, only liver and abdominal fat pad were significantly (P ≤ 0.05) affected by treatments. Reducing dietary CP generally increased weight of thighs. However, Bay g 5421 supplementation reduced any significant effect on relative weights of breast or total body protein, total body fat or ash while total body fat was increased (P < 0.01) by 28% in D2. CLA supplementation in the LP diet caused an additional 22% increase in liver weight while the abdominal fat was relatively unchanged. Conversely, Bay g 5421 supplementation reversed the increased weights of the liver and abdominal fat to the positive control (D1) weights in a dose-related manner.

Whole-body composition

Whole body composition (g kg⁻¹ fresh weight or on dry matter basis) are presented in Tables 5 and 6, respectively. Reducing dietary CP from 230 to 180 g kg⁻¹ (Table 5) had no significant effect on dry matter, total body protein or total body ash while total body fat was increased (P < 0.01) by 28% in D2. CLA supplementation in the LP diet had no significant effect on carcass dry matter, total body protein, total body fat or ash on fresh weight basis. Conversely, Bay g 5421 supplementation signifi-

Table 5. Whole-body composition (g kg⁻¹ fresh weight) of the broiler-chicken fed low-protein diets supplemented with amino acids, CLA or an α-glucosidase inhibitor

<table>
<thead>
<tr>
<th>Diets</th>
<th>CLA-enriched oil (g kg⁻¹)</th>
<th>α-glucosidase inhibitor (mg kg⁻¹)</th>
<th>Crude protein (g kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D1</td>
<td>D2</td>
<td>D3</td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>–</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>230</td>
<td>175</td>
<td>180</td>
</tr>
<tr>
<td>Dry matter (g kg⁻¹)</td>
<td>351.0a</td>
<td>362.2a</td>
<td>365.5a</td>
</tr>
<tr>
<td>(100)</td>
<td>± 12.6</td>
<td>± 7.7</td>
<td>± 14.0</td>
</tr>
<tr>
<td>Total body protein (g kg⁻¹)</td>
<td>192.8</td>
<td>185.6</td>
<td>186.3</td>
</tr>
<tr>
<td>(100)</td>
<td>± 5.9</td>
<td>± 3.1</td>
<td>± 8.4</td>
</tr>
<tr>
<td>Total body fat (g kg⁻¹)</td>
<td>110.2b</td>
<td>140.7a</td>
<td>148.5a</td>
</tr>
<tr>
<td>(100)</td>
<td>± 8.7</td>
<td>± 9.1</td>
<td>± 14.6</td>
</tr>
<tr>
<td>Total body ash (g kg⁻¹)</td>
<td>25.8ab</td>
<td>24.6ab</td>
<td>24.1ab</td>
</tr>
<tr>
<td>(100)</td>
<td>± 1.9</td>
<td>± 1.6</td>
<td>± 0.7</td>
</tr>
<tr>
<td>Protein : fat ratio</td>
<td>1.75:1b</td>
<td>1.32:1b</td>
<td>1.25:1b</td>
</tr>
</tbody>
</table>

Means ± SD are for 6 replications per diet. Values in parenthesis are percentages relative to the positive control – D1.

Table 6. Whole-body composition (g kg⁻¹ dry matter) of broiler-chickens

<table>
<thead>
<tr>
<th>Diets</th>
<th>CLA-enriched oil (g kg⁻¹)</th>
<th>α-glucosidase inhibitor (mg kg⁻¹)</th>
<th>Crude protein (g kg⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D1</td>
<td>D2</td>
<td>D3</td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>–</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>230</td>
<td>175</td>
<td>180</td>
</tr>
<tr>
<td>Total body protein (g kg⁻¹ DM)</td>
<td>549.0a</td>
<td>512.6b</td>
<td>510.6b</td>
</tr>
<tr>
<td>(100)</td>
<td>± 26.9</td>
<td>± 13.5</td>
<td>± 37.5</td>
</tr>
<tr>
<td>Total body fat (g kg⁻¹ DM)</td>
<td>314.0b</td>
<td>389.8a</td>
<td>405.5a</td>
</tr>
<tr>
<td>(100)</td>
<td>± 22.0</td>
<td>± 19.8</td>
<td>± 27.7</td>
</tr>
<tr>
<td>Total body ash (g kg⁻¹ DM)</td>
<td>73.5bc</td>
<td>67.9a</td>
<td>66.0b</td>
</tr>
<tr>
<td>(100)</td>
<td>± 5.4</td>
<td>± 3.5</td>
<td>± 3.3</td>
</tr>
<tr>
<td>Protein : fat ratio</td>
<td>1.75:1b</td>
<td>1.32:1b</td>
<td>1.27:1b</td>
</tr>
</tbody>
</table>

Means ± SD are for 6 replications per diet. Values in parenthesis are percentages relative to the positive control – D1.

Means without similar superscripts in the same row differ significantly (P ≤ 0.05).
cantly (P \leq 0.05) decreased carcass dry matter (ie increased body water by 7–8%) and reduced total body fat in the LP diet by more than 45% (ie 141 vs. 77 g kg\(^{-1}\)) to a value 70% of the HP group. Bay g 5421 supplementation also caused a highly significant (P \leq 0.001) increase in protein:fat ratio which implies its nutrient repartitioning potential in favour of lean mass accretion.

The significant (P \leq 0.05) difference in whole-body water observed in the fresh carcass warranted the computation of the body composition based on 100% dry matter (Table 6). Again, reducing dietary CP from 230 to 180 g kg\(^{-1}\) had no significant effect (on dry matter basis) on total body protein and total body ash while total body fat was increased (P \leq 0.05) by 24%. Similarly, CLA supplementation had no significant effect on total body protein and total body ash while total body fat was increased (P \leq 0.05) higher than Bay g 5421 supplements but significantly (P \leq 0.05) by 100 mg kg\(^{-1}\) inhibitor-fed chicks were 70, 86, and 55% of the HP diet or 56, 84, and 34% of the LP diet, respectively.

Table 7. Dietary energy, protein, fat and ash retention in broiler-chicks fed low-protein diets supplemented with amino acids, CLA or an α-glucosidase inhibitor

<table>
<thead>
<tr>
<th>Energy retention (MJ chick(^{-1}))</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein (g kg(^{-1}))</td>
<td>230</td>
<td>175</td>
<td>20</td>
<td>40</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Energy retention (g chick(^{-1}))</td>
<td>15.0 b</td>
<td>18.8 a</td>
<td>19.8 a</td>
<td>18.6 a</td>
<td>11.8 c</td>
<td>10.5 c</td>
</tr>
<tr>
<td>Protein retention (g chick(^{-1}))</td>
<td>321.8 a</td>
<td>330.3 a</td>
<td>333.7 a</td>
<td>303.5 a</td>
<td>324.7 a</td>
<td>276.9 b</td>
</tr>
<tr>
<td>Fat retention (g chick(^{-1}))</td>
<td>196.9 b</td>
<td>291.3 a</td>
<td>314.0 a</td>
<td>299.8 a</td>
<td>115.5 c</td>
<td>98.7 c</td>
</tr>
<tr>
<td>Ash retention (g chick(^{-1}))</td>
<td>42.0</td>
<td>42.5</td>
<td>41.5</td>
<td>37.4</td>
<td>44.4</td>
<td>36.3</td>
</tr>
</tbody>
</table>

Means \pm SD are for 6 replications per diet. Values in parenthesis are percentages relative to the positive control – D1.

Energy, protein and fat retention

Energy retention (MJ chick\(^{-1}\), Table 7) increased (P \leq 0.05) by 25% when CP was reduced from 230 to 180 g kg\(^{-1}\). Similarly, fat retention (deposition) increased by about 48% (ie, 197 vs. 291 g chick\(^{-1}\)) while neither protein nor ash retention was affected by feeding HP or LP-diets. CLA supplementation in the LP diet had no influence on energy retention and did not correct for the increased fat deposition in the LP-fed chicks. Conversely, Bay g 5421 supplementation caused a significant (P \leq 0.05) decrease in energy and fat retention (deposition) all in a dose-related manner. Only supplementing Bay g 5421 by 100 mg kg\(^{-1}\) significantly decreased protein retention. For example, the retention of energy, protein or fat in the 100 mg kg\(^{-1}\) inhibitor-fed chicks were 70, 86, and 55% of the HP diet or 56, 84, and 34% of the LP diet, respectively.

N-excretion and efficiencies of nutrients utilization

Table 8 presents the data on the efficiencies of retaining dietary energy, protein or fat. It also presents the protein efficiency ratio and the nitrogen excretion. Reducing dietary CP from 230 to 180 g kg\(^{-1}\) significantly (P \leq 0.05) increased energy, protein and fat retention efficiencies. The PER was also significantly (P \leq 0.05) improved while N-excretion was decreased. In contrast with fat retention efficiency which was increased by 64% in the LP diet (D2), N-excretion was decreased by 34%. Again, CLA supplementation in the LP diets had no significant influence on the efficiencies of nutrient retention and on N-excretion. In contrast, supplemental Bay g 5421 significantly (P \leq 0.05) decreased the nutrient retention efficiencies when compared with the HP or LP controls. For example, energy, protein, fat and body ash retention efficiencies were only 55, 88, 47 or 80%, respectively of the HP control (D1) or 47, 71, 29 or 73%, respectively, of the LP control (D2). Dietary Bay g 5421 increased N-excretion in the LP-fed chicks by about 35–60% (ie, 43 vs. 58–68 g N chick\(^{-1}\)) to the HP control levels in a dose-related manner. Similarly, the inhibitor increased faecal dry matter content in the LP-fed chicks by 16–32% (238 vs. 275–314 g kg\(^{-1}\)) relative to the HP control. Excretion of starch in faeces was increased 5 to 7.5-fold (ie 64 vs. 341–477 g kg\(^{-1}\) dry matter) also in a dose-dependent manner.

Discussion

With regard to performance characteristics, this study corroborates earlier reports (FANCHER and JENSEN, 1989; ALETOR et al., 2000) that growth, feed consumption, and feed...
**Table 8. Efficiencies of nutrients utilization in broiler-chicks fed low-protein diets supplemented with amino acids, CLA or an α-glucosidase inhibitor**

*Effizienz der Nährstoffverwertung von Broilern bei proteinarmer Fütterung und Zusatz von Aminosäuren, konjugierter Linolsäure (CLA) oder einem α-Glukosidase-Inhibitor*

<table>
<thead>
<tr>
<th>Diets</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
<th>D5</th>
<th>D6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLA-enriched oil (g kg⁻¹)</td>
<td>230</td>
<td>175</td>
<td>180</td>
<td>180</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>α-glucosidase inhibitor (mg kg⁻¹)</td>
<td>–</td>
<td>–</td>
<td>20</td>
<td>40</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Crude protein (g kg⁻¹)</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Energy retention efficiency (%)</td>
<td>36.7ᵇ</td>
<td>42.4ᵃ</td>
<td>48.1ᵃ</td>
<td>45.1ᵃ</td>
<td>23.8ᵃ</td>
<td>20.1ᶜ</td>
</tr>
<tr>
<td>Protein retention efficiency (%)</td>
<td>44.6ᵇ</td>
<td>55.3ᵃ</td>
<td>57.2ᵃ</td>
<td>53.3ᵃ</td>
<td>47.5ᵇ</td>
<td>39.3ᶜ</td>
</tr>
<tr>
<td>Fat retention efficiency (%)</td>
<td>79.5ᵇ</td>
<td>130.3ᵃ</td>
<td>151.4ᵃ</td>
<td>144.8ᵃ</td>
<td>45.9ᶜ</td>
<td>37.7ᶜ</td>
</tr>
<tr>
<td>Ash retention efficiency (%)</td>
<td>22.2ᵇ</td>
<td>24.2ᵃ</td>
<td>25.5ᵃ</td>
<td>23.4ᵃ</td>
<td>22.4ᵃ</td>
<td>17.8ᵇ</td>
</tr>
<tr>
<td>Protein efficiency ratio</td>
<td>2.4ᵇ</td>
<td>3.0ᵃ</td>
<td>3.0ᵃ</td>
<td>3.0ᵃ</td>
<td>2.4ᵇ</td>
<td>2.1ᶜ</td>
</tr>
<tr>
<td>Nitrogen excretion (g N chick⁻¹)</td>
<td>64.3ᵇ</td>
<td>42.7ᵃ</td>
<td>40.4ᶜ</td>
<td>42.8ᵃ</td>
<td>57.8ᵇ</td>
<td>68.4ᵃ</td>
</tr>
</tbody>
</table>

Means ± SD are for 6 replications per diet. Values in parenthesis are percentages relative to the positive control – D1.

Means without similar superscripts in the same row differ significantly (P < 0.05).

The efficiency of grower-broiler chicks is not significantly affected by decreasing dietary CP from 230 to 180 g kg⁻¹ when LP diets are supplemented with EAAs to meet the minimum NRC (1994) specifications. The study further demonstrates that dietary supplementation of 20–40 g kg⁻¹ CLA-enriched oil (or 14–27 g kg⁻¹ of the pure CLA equivalent) in the LP diet had no significant effect on growth rate, FC or FCE in agreement with recent reports on broilers by Simon et al. (2000) but contrasted with the increases reported for rats and mice (Chin et al., 1994; Stangl, 2000). Although CLA feeding had no significant effect on these performance indices, there was a tendency towards reduced feed intake by 8–9% to the HP control levels. In sharp contrast to CLA, dietary Bay g 5421, especially the higher level, depressed WG and FCE but increased FC in a dose-dependent fashion suggesting the possibilities of down-grading the levels to achieve optimum performance indices. While several aspects of the bioactivity of the CLAs with regard to animal performance indices remain open to questions (Azain et al., 1997; Jahreis et al., 1999; Müller et al., 2000; Stangl, 2000), that of Bay g 5421 is much better understood. Bay g 5421, an α-glucosidase inhibitor, in current use in the management of Type 2 diabetes mellitus in humans, modulates or regulates carbohydrate metabolism by competitively and reversibly inhibiting the pancreatic α-amylase and membrane-bound intestinal α-glucoside hydrolyse enzymes (Bayer, 1999). Pancreatic α-amylase hydrolyses complex starches to oligosaccharides in the lumen of the small intestine, while the membrane-bound intestinal glucosidases hydrolyse oligosaccharides, trisaccharides, and disaccharides to glucose and other monosaccharides in the brush-border of the small intestine. Conceivably, an obstruction of these carbohydrate metabolic pathways by Bay g 5421 brings about decreased dietary energy (starch) utilization and hypoglycaemia, both of which trigger increased feed consumption to meet energy needs with a concommitant decrease in growth and feed conversion efficiency in agreement with an earlier report (Kirchgessner et al., 1981). In deed, this mode of action by Bay g 5421 on dietary starch metabolism, was demonstrated in the present study by the 5 to 7.5-fold increase in the elaboration of faecal starch in inhibitor-fed chickens.

Data on selected carcass cuts indicate that neither reducing of dietary CP nor supplementing of CLA or Bay g 5421 had any significant effect on relative weights of breast or thigh, although, there was a tendency towards an 8–9% reduction in the chicks fed 100 mg kg⁻¹ inhibitor. The significant increases in the relative weights of the liver and abdominal fat in the present study are consistent with earlier reports (Fancher et al., 1989; Rosebrough and McMurtry, 1993; Aletor et al., 2000) when broiler-chicks were fed low-protein, amino acids-supplemented diets. The liver is the primary site of lipogenesis in chickens (Rosebrough and Steele, 1985) which suggests that the increased liver weight in the LP fed chicks may be related to increased fat deposition or increased lipogenic activity. While it is being established, whether or not, the increased liver weight following CLA feeding in the present study was due to fat deposition, earlier reports in rats by Scimeca (1998), Delany et al. (1999) indicated fat accumulation in the liver without pathological changes. The reversal by Bay g 5421 of the increased weights of the liver and abdominal fat to the HP levels, is an indication of its potency as a lipolytic agent, or a strong fat-to-lean partitioning effect.
The lack of significant effect of dietary CLA on whole-body composition (Tables 5 and 6) in the chicks fed low-protein amino acid-supplemented diets raises a fundamental question as to whether or not the strong fat-to-lean partitioning capabilities ascribed to dietary CLA (Pariza et al., 1996; Park et al., 1999; Jahreis et al., 1999; Simon et al., 2000; Stangler, 2000) is operational irrespective of the animal specie, feeding regimens or dietary composition. Indeed, similar reservations as to whether dietary CLA will always reduce body fat were recently expressed by Müller et al. (2000) who found no evidence of reduced fat deposition by supplemental CLA in growing pigs fed isoenergetic rations. For example, it has long been established (Bartov, 1979; Laurin, 1985) that fat supplementation has no significant effect on carcass fat if the energy:protein ratio of the diets remains constant. Whether this applies to CLA in the present study remains to be established. However, it is of interest to point out that the energy:protein ratio of the diets in the studies by Simon et al. (2000) referred to above, and in which CLA supplementation lowered carcass fatness, were narrower (62 MJ kg−1) than the 72 MJ kg−1 for the LP diets in the present study. Quite to the contrary, the classical whole-body compositional changes usually ascribed to dietary CLA such as decreased dry matter or increased body water, decreased body fat, increased body protein and increased protein:fat ratio were elicited by dietary Bay g 5421. These findings suggest that under conditions of high dietary energy:protein ratios (as in the LP diets), dietary Bay g 5421 is far more potent to influence body composition than CLA. It has also long been established that diets containing high energy:protein ratios (>72 MJ kg−1 CP) promote high rates of in vitro lipogenesis (Sebraugh and Steele, 1985) as well as de novo carcass lipid synthesis by the chicken (Donaldson, 1985) while diets with small energy:protein ratio (<56 MJ kg−1 CP) promote lean carcass. The primary mechanism involved in the reduction of carcass fatness by feeding high protein diets is the associated increased energy expenditure and increased heat increment in degrading excess amino acids to uric acid (Buttery and Boorman, 1976; Bartov, 1979; Labbie and Uzu, 1993). This hypothesis may, in part, explain the decreased energy and fat retention associated with the HP diet (D1) and the Bay g 5421 supplemented diets (D5–D6; Table 7) both of which were associated with increased N-excretion and reduced protein efficiency ratios (Table 8). Although diets 5 and 6 had lower CP content than D1 (180 vs 230 g kg−1), the increased feed intake by the inhibitor led to identical N-intake (705 vs. 723 g N chick−1, respectively) which possibly resulted in identical N-excretion. While CLA supplementation had no significant effects on energy and fat retention or their efficiencies, Bay g 5421 substantially reduced these nutrient utilization indices (including starch) in a dose-response manner. Apart from the indirect effect of body fat reduction via an increased rate of amino acid degradation and the concomitant increased N-excretion, a more direct effect of Bay g 5421 relates to the decreased digestion and absorption of carbohydrates (starch) as demonstrated in the present study. By implication, less glucose and hence metabolic citrates will become available for both Krebs cycle and lipogenesis. Lipogenesis may also be reduced by lower insulin secretion according to lower peak glucose levels and this may support the action of Bay g 5421 as a nutrient partitioning agent. While the principles of reduced dietary energy density and/or restricted feeding may be used to reduce carcass fatness in broilers, these options are unattractive economically, as the birds under these feeding regimens, will necessarily consume more feed or take longer time to attain a given market weight. Restrictive feeding seems difficult to realize in practise. Other more deep-seated biochemical implications of these dietary supplements are currently being investigated.

Conclusions and recommendations

This study demonstrates that dietary Bay g 5421 is far more potent to change body composition than CLA with regard to causing a shift in body fat deposition in favour of lean mass accretion when broiler-chicks are fed low-protein, amino-acid supplemented diets. While this strong fat-to-lean partitioning effect of the α-glucosidase inhibitor would clearly alleviate consumer concerns regarding carcass fatness (and the associated human health risks), it raises the respective economic and environmental questions of decreased feed conversion efficiency and increased N-excretion, especially in the higher (100 mg kg−1) dietary inhibitor level. However, the positive dose-related responses of these parameters indicate the possibilities of down-grading the dietary inclusion levels of Bay g 5421 to establish the optimum dose(s) that will be consistent with desirable carcass fatness, feed efficiency, and N-excretion. Consequently, further studies are recommended to establish such optimum inhibitor levels which conceivably could contribute substantially, towards the harmonization of the three major conflicting interests in intensive broiler production: economic productivity, desirable carcass quality, and the compelling need to protect the environment.

Acknowledgements

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Summary

The effect of supplemental conjugated linoleic acid (CLA) or Bay g 5421 – an α-glucosidase inhibitor – were investigated with a total of 324 male (ROSS) broiler-chicks from age 3 to 6 weeks using performance, carcass characteristics, whole-body composition and efficiencies of nutrients utilization as the response criteria. The trial comprised 6 (D1–D6) isoenergetic (13.0 MJ kg−1) broiler diets containing 230 (High-protein, HP – D1) or 180 g kg−1 (Low-protein, LP – D2) crude protein supplemented with essential amino acids (EAA) to meet the minimum National Research Council’s specifications. Diets 3 and 4 were derived from the LP diet, ie D2, by the respective supplementation of 20 or 40 g kg−1 CLA-enriched oil containing mainly the cis-9, trans-11 (34.2%) and trans-10, cis-12 (34.0%) isomers while diets 5 and 6 were similarly derived from D2 by the respective supplementation of 50 or 100 mg kg−1 Bay g 5421.

Reducing dietary crude protein from 230 g kg−1 in D1 (ie HP control) to 180 g kg−1 in D2 (LP control) had no
signifikant Effekt auf den Wirkungsgrad (WG), Futterverzehr (FC) oder Futterverwertung (FCE). Die LEP group, was 6% mehr Feed than the high protein group. CLA supplementation had no significant effect on WG, FC, or FCE, while Bay g 5421 significantly (P ≤ 0.05) reduced WG (18%), increased FC (23–28%) and depressed FCE (30–57%) relative to the control in a dose-related fashion. Neither the reduction in crude protein nor the supplementation of either CLA or Bay g 5421 significantly affected the relative weights of the breast or thigh although 100 mg kg⁻¹ of the inhibitor level reduced the carcass weights by 9–10%. Amongst the organs weighed, only the liver and abdominal fat pad were significantly (P ≤ 0.05) affected. CLA supplementation in the LP diet caused about 22% increase in liver weight while the abdominal fat pad was unchanged. Conversely, Bay g 5421 supplementation completely reversed the increased liver and abdominal fat weights in the LP diet to the HP control levels. Whole-body composition (g kg⁻¹ fresh weight or dry matter) was unaffected by feeding 230 or 180 g kg⁻¹ protein except for total body fat which was increased by 28% in the LP diet (110.2 ± 8.7 vs. 140.7 ± 9.1 g kg⁻¹). CLA supplementation in the LP diet had no significant effect on whole-body composition. Conversely, Bay g 5421 significantly (P ≤ 0.01) decreased carcass dry matter (ie. increased body water by 7–8%) and reduced total body fat by about 45% (ie. 140.7 ± 9.1 vs. 77.5 ± 5.6 g kg⁻¹) to a value 70% of the HP control. On a moisture-free basis, Bay g 5421 caused a 15–17% increase (ie, 512.6 vs. 600.0 g kg⁻¹ DM) in whole-body protein while CLA had no significant effect. Only Bay g 5421 significantly (P ≤ 0.05) increased protein: fat ratio (1.3 : 1 vs. 2.5 : 1) implying a strong fat-to-lean mass partitioning effect. CLA supplementation in the HP diet had no influence on energy retention and did not correct for the increased fat retention (deposition). It also had no effect on N-excretion. Conversely, Bay g 5421 significantly (P ≤ 0.05) decreased energy and fat retention but increased N- and faecal starch excretion in a dose-related manner.

It was concluded, that under low-protein, amino acid-supplementation and isoenergetic feeding regimens, Bay g 5421 is far more potent than CLA to change body composition in broiler-chickens. Because of the dose-related effects of Bay g 5421 especially with regard to decreased feed efficiency and increased N-excretion, further studies using down-graded levels of the inhibitor were recommended to establish the optimum dietary dose(s) that will be consistent with desirable carcass fatness, feed efficiency, and N-excretion.

Keywords
Broiler-chickens, low-protein diets, amino acids, conjugated linoleic acid, α-glucosidase inhibitor, performance, whole-body composition, N-excretion

Zusammenfassung
Wachstum, Körperfettansatz, Stickstoffausscheidung und Nährstoffverwertung von Broilern bei Niedrig-Protein-Diäten mit Ergänzung von Aminosäuren, konjugierter Linolsäure oder einem α-Glukosidase-Inhibitor

In einem dreiwöchigen Fütterungsversuch mit insgesamt 324 männlichen drei Wochen alten Broilern (ROSS) wurden die Effekte von Zusätzen konjugierter Linolsäure (CLA) oder

Bay g 5421, einem α-Glukosidase-Inhibitor, auf Wachstum, Schlachtkörpermerkmale, Ganzkörperzusammensetzung und Nährstoffverwertung untersucht. Der Versuch umfasste 6 (D1-D6) isoenergetische Futtermischungen für Broiler (13,0 MJ/kg), die pro kg 230 g Rohprotein (proteineinreich, HP–D1) oder 180 g Rohprotein (proteinarm, LP–D2) enthielten und so mit essentiellen Aminosäuren ergänzt wurden, dass die Versorgungsempfehlungen des National Research Council erfüllt waren. Für Diät D3 und D4 wurde die proteinarme Basisdiät D2 mit 20 bzw. 40 g/kg eines CLA-angereicherten Öls ergänzt, das hauptsächlich die cis-9, trans-11 (34,2%) und trans-10, cis-12 (34,0%) Isomeren enthält. Diät D5 und D6 basierten ebenfalls auf Diät D2 allerdings mit Supplementierung von 50 bzw. 100 mg/kg des α-Glukosidase-Inhibitors Bay g 5421.

Die Absenkung des Proteingehaltes von 230 g (D1) auf 180 g (D2) je kg Futter hatte keinen signifikanten Effekt auf Zunahmen, Futteraufnahme oder Futterverwertung, allerdings wurden in Gruppe D2 6% mehr Futter verbraucht als in Gruppe D1. Die CLA-Supplementierung hatte ebenfalls keine signifikanten Effekte auf die genannten Parameter, wohingegen Bay g 5421 dosisabhängig und signifikant (P ≤ 0,05) die Zunahmen um 18% verminderte, den Futterverbrauch um 23–28% erhöhte und die Futterverwertung um 30–57% verschlechterte. Die relativen Gewichtsanteile von Brust oder Schenkel wurden weder von der Proteinabsenkung noch von der Zulage an CLA oder Bay g 5421 signifikant beeinflusst, auch wenn bei 100 mg/kg Inhibitor (D6) die Schlachtkörpergewichte um 9–10% vermindert waren. Den erfassten Organen und Geweben zeigten nur Leber und Abdominalfett signifikante Behandlungseinfälle (p ≤ 0,05). So erhöhte die CLA-Ergänzung der proteinarmen Diät das Lebergewicht um 22%, während das Abdominalfett unverändert blieb. Bay g 5421 senkte dagegen die bei proteinärmer Diät (D2) erhöhten Leber- und Abdominalfettgewichte vollständig auf das Niveau der Positivkontrolle (D1) ab. Die Ganzkörperzusammensetzung war weitgehend unbeeinflusst von der Proteinversorgung, nur der Gesamtfettgehalt war bei der proteinarmen Diät (D2) um 28% erhöht (141 gegenüber 110 g/kg). Die CLA-Ergänzung hatte keinen signifikanten Effekt auf die Ganzkörperzusammensetzung. Bay g 5421 verminderte dagegen signifikant (p ≤ 0,01) den Trockenmassegehalt im Schlachtkörper um 7–8% und verminderte den Gesamtfettgehalt um etwa 45% (78 gegenüber 141 g/kg) auf 70% der Positivkontrolle D1, Bezogen auf Trockenmasse erhöhte Bay g 5421 den Proteininhalt des Ganzkörpers um 15–17% (600 gegenüber 513 g/kg T) während CLA keinen signifikanten Einfluss zeigte. Das Protein:Fett-Verhältnis wurde nur von Bay g 5421 signifikant (p ≤ 0,05) erhöht (2,5 : 1 gegenüber 1,3 : 1), was auf eine starke Beeinflussung der Körperzusammensetzung zugunsten des Fleisch- gegenüber dem Fettansatz hinweist. Die CLA-Ergänzung der proteinarmen Diät hatte keinen signifikanten Effekt auf die Energieretention und konnte die erhöhte Fettretention (-einhärtung) nicht verhindern. CLA hatte auch keinen Einfluss auf die Stickstoffausscheidung. Demgegenüber verminderte Bay g 5421 dosisabhängig und signifikant (p ≤ 0,05) die Energie- und Fettretention bei erhöhter Stickstoff- und Stärkeausscheidung.

Die vorliegenden Ergebnisse zeigen, dass bei proteinärmer, aminosäurengesättigter, isoenergetischer Fütterung der α-Glukosidase-Inhibitor Bay g 5421 ein wesentlich wirksameres Mittel zur Beeinflussung der Körperzusammensetzung beim Broiler darstellt als konjugierte Linolsäure (CLA). Wegen der dosisabhängigen Wirkung von Bay g 5421 insbesondere in Hinblick auf eine geschlechtere Futterverwertung und eine erhöhte Stickstoffausscheidung, sind weitere Dosis-Wirkungs-Studien mit dem Inhibitor erforderlich, um optimale Dosierungsempfehlungen geben zu können, die auch die erwünschten Werte bei Körperverfettung, Futterverwertung und Stickstoffausscheidung gewährleisten.

Stichworte
Broiler, proteinarme Diäten, Aminosäuren, konjugierte Linolsäure, α-Glukosidase-Inhibitor, Leistung, Ganzkörperzusammensetzung, Stickstoffausscheidung
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Correspondence: Prof. V. A. Aletor, Division of Nutritional Biochemistry, Department of Animal Production & Health, The Federal University of Technology, PMB 704, Akure, Nigeria.