Increased dietary balanced protein levels at varying length of application in 1-14 days old broilers

A. LEMME[1*], M.G.T. JANSSEN[2], P.J.A. WIJTTEN[2], J.K.W.M. SPARLA[2], M. REDSHAW[1]

[1]Degussa GmbH – Feed Additives, Rodenbacher Chaussee 4, 63457 Hanau, Germany, [2]Provimi B.V., P.O. Box 5063, NL-3008 AB, Rotterdam, The Netherlands
***Corresponding author:** andreas.lemme@degussa.com

In the present trial increasing levels of balanced protein (BP; 100 (control), 115, 130, 145, 160% of recommendation) were fed from day one either for two, four, eight, or twelve days to male broilers (control + 4 x 4). After feeding the experimental diets dietary BP was reduced to the control level. This was done in two steps (2-day transition period) in order to avoid too strong changes in amino acid supply. Increasing BP levels non-linearly improved weight gain and feed conversion. This effect was most pronounced when experimental diets were fed for 12 days ($p<0.05$). Feeding increasing BP levels for two or four days had no effects on weight gain and feed conversion ratio. On day 14 two birds per pen were selected for dissection. Weights of the empty small intestine were determined. Enhancing the length of feeding the experimental diets from 2 to 12 days significantly increased the relative weight of the duodenum and jejunum (% of body weight) whilst dietary BP had no effect. However, small intestine weight of the control treatment was similar compared with that of birds received the experimental diets for 8 and 12 days.

Keywords: balanced protein, broiler, phase length, early nutrition

Introduction

Nutrition of the young chicken is important for the overall performance until market weight. In this context supply with balanced amino acids or balanced protein (BP) plays a central role. Wijtten et al. (2004) reported that increasing levels of BP (1.10-1.42 % true fecal digestible Lys) in the starter diet linearly increased the 14-day weight of male and female broilers by almost 11 g per 0.10 % TFD Lys. After feeding recommended BP levels in the grower (14-30 d) and finisher phase (30-37 d) this linear effect developed to almost 21 g per 0.10 % TFD Lys in the starter feed. Research by Sklan and Noy (2003) described a similar relationship. However, during first days post-hatch nutrient utilisation for performance might be confounded by nutrient release from the yolk sac. Bigot et al. (2003) compared overall growth and growth of various organs both with an early feed supply and with a delay in feed supply and data suggested that the nutrient release from the yolk sac met the maintenance requirement but for additional performance nutrients from feed were needed. In this context the growth particularly of the intestinal tract is of importance because of its function of nutrient absorption. At early supply with feed the gastro-intestinal tract grew faster (Bigot et al., 2003).

The aim of the present experiment was to investigate the effects of graded levels of BP fed for increasing numbers of days on broiler growth and development of the intestinal tract.

Materials and methods

In total 1728 male day-old Ross 308 chicks were equally distributed to 72 pens in a way that average starting weight was 44.8±0.1 g/chick. Pens were assigned to 17 treatments including one control (8 pens) in which the broilers received a diet meeting 100 % of the amino acid

recommendation (1.10 % TFD Lys) throughout the experimental period of 14 days. The remaining 16 treatments were replicated four times and followed a 4x4 factorial arrangement with increasing levels of balanced protein (115, 130, 145, 160 % of recommendation corresponding to 1.26, 1.42, 1.57, 1.73 % TFD Lys) and four pre-starter phase lengths (0-2, 0-4, 0-8, 0-12 days). After feeding the experimental diets the 100 % control diet was fed. However, to smoothen the transition between the increased BP levels and the following control diet, a transition period of two days was introduced where the BP were gradually reduced. For example after feeding the 160 % BP (145, 130, 115 %) diets birds got the next day 140 % BP (130, 120, 110 %) and the second day 120 % BP (115, 110, 105 % BP) before reaching the 100 % BP level.

The experimental diets as well as the transition diets consisted mainly of corn, wheat, and soybean meal but also other ingredients including free amino acids. While the BP protein ranged between 100 % and 160 %, the ratios digestible Lys were maintained with 77, 64, 20, 112, 75 and 82 % for dig. Met+Cys, dig. Thr, dig. Trp, dig. Arg., dig. Ile, and dig. Val, respectively. Amino acid analysis confirmed the calculated valued. The feeds were offered in pelleted form.

Table 1 Ingredients and nutrient composition of the basal starter, grower, and finisher diet.

Ingredients, %	Balanced protein 100 %	160 %	Energy and nutrients, %	Balanced protein 100 %	160 %
Corn	53.4	27.0	Energy, MJ ME/kg*	12.7	13.0
Wheat	15.0	15.0	Ether extract	4.4	7.7
Soybean meal	14.3	29.0			
Fish meal	3.0	6.0	Crude Protein	20.5	32.0
Soybean isolate	3.0	6.0	TFD Lys**	1.10	1.73
Full-fat soybeans	2.5	5.0	TFD Met + Cys	0.85	1.32
Corn gluten meal	2.0	2.0	TFD Thr	0.71	1.11
Potato protein	1.0	2.0	TFD Trp	0.21	0.35
DL-Met	0.22	0.42	TFD Arg	1.22	1.98
L-Lys HCl	0.19	0.04	TFD Ile	0.82	1.32
L-Thr	0.03	0.02	TFD Val	0.90	1.41
L-Arg	0.06	-			
Glycine	0.04	0.04	Calcium	1.00	1.00
L-Val	0.02	0.02	Phosphorus	0.67	0.71
Fat, minerals, vitamins	5.24	7.46	Available phosphorus	0.45	0.45

*both energy values correspond to 11.9 MJ $ME_{Broiler}$/kg; ** TFD: true fecal digestible

Ambient temperature was decreased from 34 °C to 20.8 °C in weekly steps of 2.5 °C. Lights were off 1 hour per day and the relative humidity was 50 %. All birds had unlimited access to feed and drinking water.

Chick weights were recorded per pen at start of the experiment, and individually at 7 and 14 days of age. Feed consumption for each pen was recorded at the day of feed change and at days 7 and 14. Subsequently, feed conversion ratio which was corrected for mortality was calculated. On d 14 two birds per pen were selected for dissection. The weight of the whole bird, the empty gizzard+proventriculus, and empty sections of the intestine (duodenum, jejunum, ileum, caecum), pancreas and liver were determined.

Data were subjected to analysis of variance using Genstat (8th edition) using the following model:

$Y_{ijklm} = \mu + AA_i + FD_j + R_l + AA*FD_{ij} + e_{ijklm}$

with AA_i = effect of amino acid level (i = 100, 115, 130, 145 and 160), FD_j = effect of feeding period starter diet (j = 2, 4, 8 and 12), $AA*FD_{ij}$ = interaction of AA_i and FD_j and e_{ijklm} = residual error.

The level of significance was chosen at $p<0.05$.

Results and discussion

Lowest weight gain of all treatments was achieved in the control treatment but, however, this performance was about 25 % higher than expected from the breeder's performance objectives (Aviagen, 2002). Feeding any of the experimental diets longer than 4 days improved significantly weight gain (Table 2) compared to the control. This is in line with observations by Jamroz et al. (2006) who fed graded levels of dietary Methionine and who determined the broiler chick weights at arrival, at days 1, 3, 5, 7 and 14. They reported significant dose-response effects on growth for birds 5 days old and older. Plotting the weight gain data against the dietary BP level and the pre-starter phase length suggest that the most promising strategy might be feeding 130, 145, and 160 % BP for 12 days (Figure 1). In these treatments birds gained on average 50 g more than the control. Exponential regression on the 12 day data suggest an optimum BP level of 147 % (95 % of asymptotic response, Y=512+54*(1-EXP(-0.063*(BP-100))))

Considering only treatments 2 to 17, feed intake gradually and significantly decreased from average 635 g to average 607 g with increasing length of the pre-starter phase. Moreover, the increase of the BP level from 115 % to 145 % stepwise decreased feed intake. So, lowest feed intake was observed when 145 % or 160 % BP was fed for 12 or 8 and 12 days. Feed intake of treatment 1 fits to this scheme in so far as feeding the experimental diets for 12 days describe a non-linear response for feed intake.

Statistically, feed conversion ratio responses showed the only interaction between both factors (Table 2) reflecting the effects on weight gain and feed intake. Accordingly, feed conversion improved with both increasing dietary BP level and length of pre-starter phase resulting in best performance at 145 % and 160 % BP fed for 12 days. Exponential regression even revealed optimum dietary BP levels higher than 160 % at a 12 day pre-starter phase length (Y=1.205-0.170*(1-EXP(-0.35*(BP-100)))). The data again suggest that a pre-starter phase shorter than eight days had no effect.

Table 2 Effects of increasing levels of balanced protein (BP) and increasing pre-starter phase length on feed intake, weight gain, and feed conversion ratio as well as on relative weight of the duodenum, jejunum, and ileum in 14 days old male broiler chicken.

Treatment	BP level (%)	Prestarter phase length, d	Feed intake, g	Weight gain, g	Feed per gain* g/g	Duodenum % of BW	Jejunum % of BW	Ileum % of BW
1	100	0	617 ^{abcd}	512 ^{f}	1.205 ^{ab}	0.94 ^{cde}	1.69 ^{abcd}	1.34 ^{b}
2	115	2	642 ^{a}	528 ^{def}	1.214 ^{ab}	0.86 ^{abcd}	1.67 ^{abcd}	1.24 ^{ab}
3	115	4	639 ^{a}	536 ^{cde}	1.192 ^{bc}	0.94 ^{bcde}	1.80 ^{cd}	1.29 ^{ab}
4	115	8	635 ^{a}	541 ^{bcde}	1.174 ^{cd}	0.90 ^{abcde}	1.79 ^{abcd}	1.21 ^{ab}
5	115	12	616 ^{abcd}	544 ^{abcd}	1.133 ^{ef}	0.82 ^{abcd}	1.69 ^{abcd}	1.30 ^{ab}
6	130	2	633 ^{ab}	522 ^{def}	1.214 ^{ab}	0.75 ^{a}	1.68 ^{abcd}	1.22 ^{ab}
7	130	4	631 ^{abc}	530 ^{def}	1.193 ^{bc}	0.88 ^{abcd}	1.67 ^{abcd}	1.26 ^{ab}
8	130	8	621 ^{abcd}	537 ^{cde}	1.157 ^{de}	0.79 ^{abc}	1.55 ^{a}	1.36 ^{b}
9	130	12	615 ^{abcd}	558 ^{abc}	1.101 ^{g}	1.07 ^{e}	1.80 ^{bcd}	1.32 ^{ab}
10	145	2	624 ^{abcd}	524 ^{def}	1.191 ^{bc}	0.79 ^{ab}	1.57 ^{abc}	1.20 ^{ab}
11	145	4	622 ^{abcd}	521 ^{ef}	1.194 ^{bc}	0.82 ^{abcd}	1.55 ^{ab}	1.16 ^{a}
12	145	8	617 ^{abcd}	544 ^{abcd}	1.135 ^{ef}	0.84 ^{abcd}	1.75 ^{abcd}	1.31 ^{ab}
13	145	12	602 ^{cd}	566 ^{a}	1.064 ^{h}	0.91 ^{abcde}	1.72 ^{abcd}	1.30 ^{ab}
14	160	2	642 ^{a}	525 ^{def}	1.223 ^{a}	0.93 ^{bcde}	1.56 ^{abc}	1.24 ^{ab}
15	160	4	620 ^{abcd}	520 ^{ef}	1.194 ^{bc}	0.82 ^{abcd}	1.56 ^{abc}	1.17 ^{a}
16	160	8	604 ^{bcd}	535 ^{de}	1.129 ^{f}	0.96 ^{cde}	1.62 ^{abc}	1.28 ^{ab}
17	160	12	594 ^{d}	562 ^{ab}	1.058 ^{h}	0.99 ^{de}	1.90 ^{d}	1.29 ^{ab}
LSD			*30*	*23*	*0.026*	*0.18*	*0.25*	*0.18*

$^{(a-j)}$Means within a column with different superscripts differ significantly (P<0.05).

* For feed conversion ratio there was a significant interaction BP level x pre starter phase length p<0.001

Increasing dietary BP levels had no effect on relative length of the small intestine suggesting that development of the gastro intestinal tract was not stimulated disproportionately. Jamroz et al. (2006) observed a significantly increased relative length of the duodenum with increasing dietary Methionine in 7-days old broilers but no effect on jejunum and ileum length. However, in absolute units the digestive tract was greater in bigger birds and it can be speculated whether a heavier (or longer) intestine was the prerequisite for improved growth or not.

From the experimental results presented above it can be concluded that

1. Feeding a pre-starter diet with increased balanced protein is only beneficial if fed longer than four days.
2. Best performance can be expected when diets with high balanced protein levels (>145 % of CVB recommendation; >1.57 % TFD Lys) are fed for 12 days.
3. Growth of the digestive tract is not stimulated disproportionately.

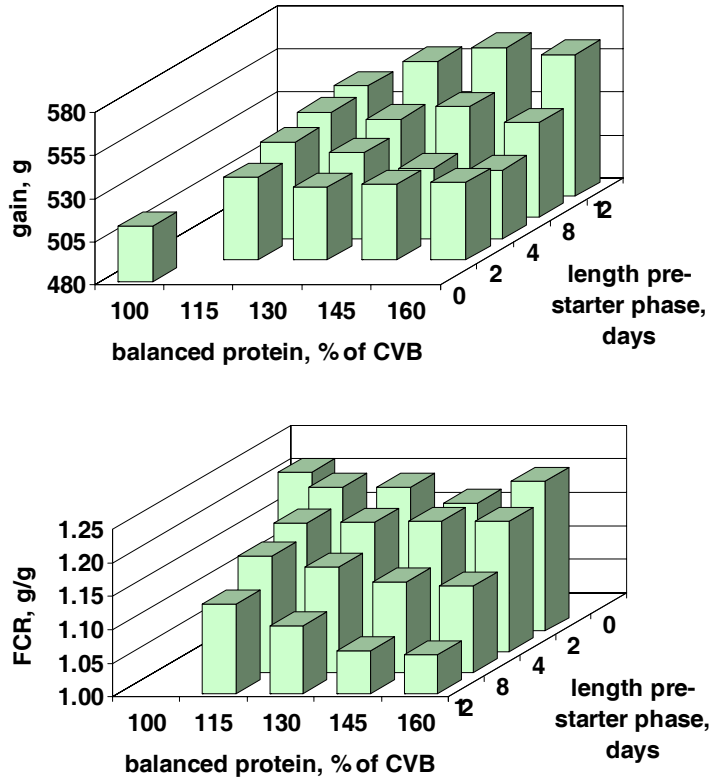

Figure 1 Weight gain (top) and feed conversion ratio (FCR, bottom) responses of male 1 – 14 days old broilers to increasing dietary levels of balanced protein in the pre-starter diet at increasing length of the pre-starter phase.

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