Methionine requirements for optimal health and welfare in fast-growing organic broilers

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In Sweden, only fast growing broiler hybrids are available for organic production, and due to the required rearing period of 10-12 weeks growth rate restrictions are needed. Organic feed legislation further complicates the composition of a well balanced diet, which may affect animal health. The experiment comprised 180 Ross 308 broilers divided over 3 dietary treatments; a low crude protein and methionine diet; or a high crude protein diet with similar amino acid levels as used in conventional production, both composed according to organic standards; or the low protein diet supplemented with lysine, methionine and threonine up to levels of the high protein diet; Chickens were immunologically challenged with an inactivated IBDV vaccine, and antibody titres, heterophil/lymphocyte ratios, and lymphoid organ weights were studied. The high protein diet gave the highest live weight and the most efficient FCR. Supplementing the low protein diet with amino acids increased live weight and FCR, even though the effect on FCR at 10 wks was less pronounced. Dietary treatments did not significantly affect any of the immune or stress related parameters measured,, indicating that amino acid levels obtained in the organic diets studied are sufficient for the birds to maintain an adequate immune response.

Keywords: broiler; organic; protein; methionine; immune responses

Introduction

Organic broiler production in Sweden is still on a comparatively small scale, but the consumers´ demands for these products are increasing. Keeping slow-growing hybrid parent stock has, so far, been considered unfeasible due to the low need for the progeny, and national quarantine requirements prevent import of day-old chicks. Therefore, only conventional, fast-growing broiler hybrids are available for organic production.

Due to their plumage, in combination with a fast growth, broilers have high requirements for sulphur-rich amino acids, especially methionine. According to national organic standards, 85% of the feedstuffs in poultry diets have to be organically approved, with the aim to reach 100% by 2012 (National Board of Agriculture, 2007). However, most organically approved feedstuffs available have a relatively low content of sulphur-rich amino acids, and as supplementation of pure amino acids is not allowed, it is difficult to achieve a good amino acid balance in organic broiler diets. An unbalanced amino acid composition may, apart from impaired production, also jeopardize animal health and welfare through negative effects on immune responses (Chen et al., 2003; Konashi et al., 2000; Kwak et al., 1999).

EU regulations stipulate a rearing period of 10-12 wks for organic broilers. To sustain good animal welfare in fast-growing hybrids during rearing periods of 10-12 wks, growth restrictions are needed. One way of achieving this is by a qualitative feed restriction, i.e. a less concentrated, low protein diet.

The purpose of the present study was to investigate production, health and immune responses of broilers fed organic diets varying in crude protein and methionine contents.

Materials and methods

180 unsexed Ross 308 chickens were randomly distributed over 45 pens (1.50 x 0.75 m) with initially 4 chickens per pen. The birds were kept on wood shavings litter from day-old up to slaughter at 70 d, with free access to water and pelleted feed. The study included 3 dietary treatments (*Table 1*) with 15 replicates (pens) each. A basal diet was composed according to organic standards to give a relatively low crude protein level, resulting in low methionine content. The second diet (low protein + aa) consisted of the same basal diet supplemented with pure amino acids (lysine, methionine, and threonine) up to levels used in conventional production (Ross manual, 2002). The third diet was optimized according to organic standards to give similar amino acid levels as the supplemented, low protein diet. This resulted in a high crude protein diet.

Table 1. Nutrient contents of the experimental diets

	Starter (0-21 days)			Grower (21-70 days)		
Analysed nutrient content (%)	**High protein**	**Low protein**	**Low protein + aa**	**High protein**	**Low protein**	**Low protein + aa**
ME[1],	12.00	12.00	12.00	12.00	12.00	12.00
Crude protein	19.9	16.3	16.4	18.0	16.4	16.1
Lysine	1.04	0.78	1.02	0.93	0.84	0.89
Methionine	0.38	0.31	0.39	0.35	0.31	0.33
Methionine+cysteine	0.70	0.59	0.66	0.67	0.60	0.61
Threonine	0.80	0.60	0.88	0.71	0.64	0.71
Linoleic acid[1]	1.30	1.30	1.30	1.13	1.07	1.13

[1]Calculated

Live weight gain and feed intake was recorded weekly. All birds that died or were culled due to weakness during the experiment were autopsied.

Chickens were immunologically challenged by subcutaneous injections with an inactivated IBDV vaccine (Nobilis Gumboro Inac Vet.; Intervet) at 18 and 42 d. At 16 and 20 d post vaccination (34 and 62 d), two randomly selected birds per pen, in total 90 birds, were individually weighed and bled. Blood smears were prepared, and heterophils and lymphocytes were counted on in total 200 cells for calculation of heterophil/lymphocyte ratio (H/L). Levels of IBDV antibodies were determined on sera at a 1:500 dilution using a commercial IBDV antibody test kit (IDEXX laboratories Inc., US). After bleeding, one of the two bled birds per pen was euthanized and spleen, bursa of Fabricious, and thymus lobes were stripped from adhering tissue and weighed. Lymphoid organs as percentage of body weight were calculated for each bird.

Results and discussion

Chickens given the high protein diet were significantly heavier than chickens given the low protein diet during the whole rearing period (*Table 2*). Birds given the high protein or low protein + aa diet had comparable live weights up to 35 d, but at 70 d the high protein group had a significantly higher live weight. At 70 d, total feed intake did not significantly differ between dietary treatments. Around 3-4 wks of age, large feed spillage was observed for the chickens given the low protein diet, explaining the higher feed conversion ratio (FCR) at early ages.

Mortality was low during the whole experiment. However, from 49 d culls (due to leg weakness) were high for birds given the high protein and low protein + aa diet. No chicken given the low protein diet had to be culled.

Table 2. Effects of dietary treatment on live weight, accumulated feed intake and FCR, (lsmeans)

		Dietary treatment			
	Age (d)	**High protein**	**Low protein**	**Low protein + aa**	**Sign.(P)[1]**
Live weight (g)	21	697[a]	399[b]	677[a]	***

	35	1800[a]	1083[b]	1714[a]	***
	70	4631[a]	3868[b]	4264[c]	***
Feed intake (g)	21	1162	1120	1150	0.88
	35	3131[a]	2565[b]	3307[a]	***
	70	9823	9003	9747	0.09
FCR (g/g)	21	1.67[a]	2.85[b]	1.70[a]	***
	35	1.74[a]	2.38[b]	1.93[a]	***
	70	2.12[a]	2.33[b]	2.29[b]	***

[1]Significance (sign.)* P<0.05, **P<0.01, ***P<0.001.
[a-c]Means within a column with no common superscript differ at p<0.05.

Dietary treatment did not significantly affect H/L or serum IBDV antibody titres. At 62 d chickens given the high protein diet had significantly higher spleen weights than chickens given the low protein diet. However, relative lymphoid organ weights (lymphoid organ weight as percentage of body weight) did not differ significantly between treatments for any organ (*Table 3*).

Deficiency or excesses of dietary protein or amino acids has previously been shown to alter immune responses in chickens (Chen et al., 2003; Konashi et al., 2000), but it seems that the levels obtained in the organic diets studied are sufficient for the birds to maintain an adequate immune response.

Table 3. Effects of dietary treatment on thymus, spleen and bursa of Fabricious at 62 d (g and percentage of body weight), and serum IBDV antibody titres and H/L

	Dietary treatment			
Weights	**High protein**	**Low protein**	**Low protein + aa**	**Sign. (P)[1]**
Body weight (g)	4147[a]	3595[b]	3968[c]	***
Spleen (g)	3.67[ac]	2.96[bc]	3.24[c]	*
Spleen/body weight (%)	0.089[a]	0.082[a]	0.081[a]	0.37
Thymus (g)	14.45[a]	14.92[a]	13.17[a]	0.64
Thymus/body weight (%)	0.35[a]	0.41[a]	0.33[a]	0.14
Bursa (g)	5.71[a]	6.23[a]	5.51[a]	0.62
Bursa/body weight (%)	0.14[a]	0.18[a]	0.14[a]	0.22
serum IBDV antibody titres	1.28	1.33	1.08	0.45
H/L	0.48	0.41	0.47	0.45

[1]Significance (sign.)* P<0.05, **P<0.01, ***P<0.001.
[a-c]Means within a column with no common superscript differ at p<0.05.

In conclusion, the high protein diet gave the highest live weight and the most efficient FCR. Supplementing the low protein diet with amino acids increased live weight and FCR, even though the effect on FCR at 70 d was less pronounced. Dietary treatments did not significantly affect heterophil/lymphocyte ratio, antibody titres or relative lymphoid organ weights, indicating that the amino acid levels obtained in the organic diets studied are sufficient for the birds to maintain an adequate immune response.

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