

## Protein supply for organic poultry: options and shortcomings

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### Introduction

In accordance with the principles of organic farming, poultry is unlikely to play a role similar to its role in conventional farming. Nevertheless, a considerable number of organic farmers specialized on the production of organic poultry products in the last decade. For most of them, supplying their poultry flocks with sufficient amounts of high quality-protein presents a challenging task. In order to fulfil this, several factors have to be taken into account (Zollitsch *et al.*, 2004).

Feed protein is broken down to amino acids (AA) and peptides, which form the precursors for tissue and egg formation. The genetic potential of animals for primary performance criteria have traditionally been seen as key targets when estimating nutrient requirements of farm livestock. More recently, nutritionists have started to pay more attention to the formation of antibodies and the amount of AA required for this process (Kidd, 2000; Konashi *et al.*, 2000; Chen *et al.*, 2003).

For feeding management purposes, suggested nutrient contents per kg of diet, rather than required daily nutrient intakes, will be used in this paper.

### Laying hens: performance and dietary nutrient density

Frequently used laying hen hybrids have the potential to annually produce more than 18 kg of egg mass per hen (300 eggs with an average egg weight of 61.5 to 64.5 g). According to breeders' management guides, the rations for these hens should contain 163 g/kg crude protein, 3.6 g/kg methionine and 7.3 g/kg lysine from week 29 onwards. These suggestions are based on a daily feed intake of 120 g. Following a phase feeding concept, nutrient density should be increased in the layer starter feed (until week 28) and can be lower after week 45 (Lohmann, 2004).

Diet formulations that are frequently used in organic farming rely on conventional protein supplements, e.g. maize gluten, to achieve the values given above (Table 1). Grain legumes and oilseed expellers will be the predominant organic protein sources.

Table 1      Rations for laying hens (Zollitsch *et al.* 2003, Joost Meyer, 2004)

Component, %	+ conventional components	100 % organic components
Triticale, wheat, maize	48.0	50.0
Peas, faba beans, lupins	25.0	--
Maize gluten (conventional)	10.0	--
Expeller (sunflower, soybean)	--	35.0
Alfalfa meal, dehydrated	5.0	5.0
Fat	2.0	--
Minerals + premix	10.0	10.0
ME, MJ/kg	11.2	10.1
CP, g/kg	187	160
Met, g/kg	3.4	2.8
Lys, g/kg	7.0	6.8

Very little field data are available on the actual AA supply from organic laying hen diets. Preliminary results from a recent field study in Austria are given in Table 2 (Velik, 2004). Samples were taken from mixed diets which were manufactured by the dominant regional feedmills. As expected, AA contents are significantly lower in organic as compared to conventional complete diets. First estimates from statistical analysis point to the severity of feather pecking being higher with decreasing Met and Met/ME.

Table 2 Amino acid and energy content in diets of free range laying hens (Velik, 2004)

Trait	Conventional diets n = 9			Organic diets n = 13		
	$\bar{x}$	min.	max.	$\bar{x}$	min.	max.
CP, g/kg	185	175	198	181	167	198
Met, g/kg	4.6	4.1	5.0	3.4	3.1	3.9
Met+Cys, g/kg	7.8	7.1	8.4	6.9	6.1	7.4
Lys, g/kg	8.4	7.9	9.5	6.7	5.8	7.6
ME <sup>1)</sup> , MJ/kg	11.5	10.9	12.3	11.8	11.2	12.2
Met/ME, g/MJ	0.40	0.36	0.43	0.28	0.25	0.33

<sup>1)</sup> estimates based on proximate nutrient analysis:

ME (kJ)=15.51\*CP+34.31\*EE+16.69\*St+13.01\*Su;

EE=ether extracts, St = starch, Su = total sugar

### Growing poultry

The situation for broilers is somewhat different to that for laying hens: broiler genotypes that are used in organic farming as well as in conventional free range-label programs show a growth pattern which is significantly different from that of conventional broilers. Therefore, their AA requirements will be covered by dietary protein contents that are lower than those from conventional diets (Peter *et al.*, 1997a): a CP content of

200 g/kg (4.3 g/kg methionine) and a ME density of 10.9 MJ/kg will probably lead to maximum growth rates in these hybrids (Table 3). Carcass traits also will not be affected by moderately reduced nutrient densities (Peter *et al.*, 1997b).

Table 3 Effects of dietary CP (AA) and ME on growth and feed conversion of "Label" broilers (Peter *et al.* 1997a)

CP (Met), g/kg	BW <sup>1)</sup> (56 days), g	BW <sup>1)</sup> (84 days), g	FCR <sup>2)</sup>
150 (3.2)	1441 <sup>a</sup>	2525 <sup>a</sup>	2.74
175 (3.8)	1559 <sup>b</sup>	2683 <sup>b</sup>	2.69
200 (4.3)	1762 <sup>c</sup>	2780 <sup>c</sup>	2.74
225 (4.9)	1799 <sup>c</sup>	2791 <sup>c</sup>	2.70
250 (5.4)	1804 <sup>c</sup>	2786 <sup>c</sup>	2.75
ME, MJ/kg			
10.9	1745 <sup>b</sup>	2782 <sup>b</sup>	2.98 <sup>c</sup>
12.1	1662 <sup>a</sup>	2705 <sup>a</sup>	2.67 <sup>b</sup>
13.3	1636 <sup>a</sup>	2652 <sup>a</sup>	2.52 <sup>a</sup>

<sup>1)</sup> BW = body weight

<sup>2)</sup> FCR = feed conversion ratio

<sup>a, b, c</sup> = different superscripts indicate significant ( $P \leq 0.05$ ) differences between group means

While protein and methionine contents of about 180 and 3.2 g/kg, respectively, are typical for organic fattening diets, variable protein and AA levels can be found in grower diets (up to week 5; Table 4).

Table 4 Grower diets for organic broilers, containing different amounts of conventional feedstuffs (Zollitsch *et al.* 2003, Weller 2004)

Component, %	Diet A	Diet B
Wheat, triticale, maize, barley	55.0	49.3
Peas, faba beans, lupins, soybeans	25.6	20.0
Expeller (sunflower, soybeans)	5.0	24.0
Maize gluten (conventional)	--	2.0
Potato protein (conventional)	10.0	--
Fat	1.8	1.0
Minerals + premix	2.6	3.7
ME, MJ/kg	12.3	12.1
CP, %	22.0	19.8
Met, %	0.39	0.39
Lys, %	1.25	1.02

Even if diets are exclusively based on organic grain legumes and oilseed cakes, dietary protein and methionine levels will probably satisfy the nutritional needs of adapted broiler strains. The current practice of growing organic broilers can, therefore, be used

as a model for addressing nutritional challenges by a multifactorial approach, including the animals' genetic background.

A situation which is quite different from organic broilers is found in turkeys. Modern (conventional) turkey hybrids can be seen as the role model for high performing growing birds which are extremely difficult to feed under organic management. Heavy meat type hybrids have the potential to grow to weights of about 10 kg in 16 weeks (female) and 22 kg in 22 weeks (male). Alternative strains, which are frequently bronze coloured, typically reach about 78 % of these weights in the same time if they are fed with conventional diets (Table 5; BUT, 2004; Kelly-turkeys, 2004). Unlike with broilers, lysine can be expected to be the first limiting AA for growing turkeys. The recommended values for the first two phases (i.e. up to week 8) given in Table 5 are extremely unlikely to be reached with diets that comply with organic farming regulations.

Table 5 Recommended dietary nutrient contents for various turkey strains (BUT 2004)

Phase, weeks	ME, MJ/kg	Lys, g/kg	Met, g/kg	Met+Cys, g/kg
0-4	11.8	18.5	6.7	12.0
4-8	12.0	16.1	6.3	11.3
8-12	12.2	13.4	5.7	10.1
12-16	12.2	10.9	4.9	8.7
16-20	12.4	9.3	4.4	7.9
20-24	12.6	8.2	4.0	7.2

Scientific data on the consequences of AA undersupply of growing turkeys are scarce. Reports from farmers and extension personnel point to severe growth depression and highly variable body condition within the flock. The depression of feed intake, which is usually observed after ingestion of AA deficient diets, eventually ends in total feed refusal in the case of young turkeys. Feed manufacturers try to avoid these problems by including high quality protein feedstuffs in the compound diets, such as processed soybeans, potato protein, yeast, dried milk or egg products. These ingredients are, however, not always available from organic sources and/or are very costly.

### Shortcomings and solutions

Based on the above information, the following major shortcomings can be identified:

- High probability for diets being (at least temporarily) deficient in AA for young turkeys and high performing laying hens.
- The situation will become even more difficult if conventional protein supplements cannot be used any more, due to the shortage of organic high quality-protein concentrates.
- Because of the linkage between genetics and nutrition, the use of conventional, high potential-strains is one of the key factors in this context.

The following options should be discussed, in order to cope with the above-mentioned shortcomings:

- Use of genetic strains with a moderately lower potential for protein deposition and egg production, together with optimization of the use of protein feedstuffs produced on farm, especially grain legumes;
- Identification of suitable bought in-protein supplements (e.g. oilseed cakes, milk and egg products); and
- Research and implementation of innovative nutritional strategies (e.g. increasing feed intake through lowered dietary energy density).

While the first option has been discussed for about a decade, broilers are the only major poultry category for which this has been implemented. In the case of laying hens, it seems unlikely that the major breeding companies will come forward with "organic layer breeds" in the near future, simply because of the limited size of the market (Damme, 2004). Turkey breeds, with a somewhat lower growth rate, are available, but even these strains require very high AA contents in their grower diets.

In the short term perspective, priority should, therefore, be given to the optimum use of protein feedstuffs available on farm. This can be done if information is provided concerning

- the actual nutrient content of different species and varieties of grain legumes;
- the content of secondary constituents of the respective plant feedstuffs and their potential negative effects on poultry;
- the suitability of processing technologies for improving the nutritive value of these feedstuffs; and
- maximum inclusion rates which can be derived based on the above information.

Data about the nutritive value of important organic protein feedstuffs is currently collected by researchers in several European countries. The potential variety in the feeding value of grain legumes can be demonstrated by preliminary data which were collected for different varieties of peas at the University of Natural Resources and Applied Life Sciences Vienna (Table 6).

Table 6 Nutritional value of peas (g/kg DM; Starz 2004).

Trait	Variety							
	1	2	3	4	5	6	7	8
CP	224	239	239	228	250	261	254	245
Fibre	71	72	70	67	69	77	75	72
Starch	531	529	514	539	519	479	479	514
Lys	15.4	16.0	15.9	16.1	16.4	17.1	17.1	14.1
Met+Cys	5.1	5.1	5.2	5.1	5.2	5.5	5.7	5.1
Thr	7.8	7.9	8.1	8.0	8.2	8.8	9.1	7.9
Try	2.0	2.0	2.1	2.1	2.1	2.2	2.2	2.0
Tannins	0.5	0.5	1.5	2.0	1.3	9.6	9.6	6.7

AA content may vary by 10 to 20 % for different varieties. In this study, the types that had highest protein content, had significantly higher amounts of tannins, which will limit their inclusion rates in poultry diets. Besides tannins (which are sometimes referred to as "bitter constituents"), other secondary constituents may potentially harm poultry if ingested in substantial quantities: protease inhibitors, hemagglutinins (lectins), saponins and cyanogens can be found in the seeds of many legumes. While their basic mode of action is relatively well known, it is not always clear to which extent they may harm the animals' metabolism if they are included in poultry diets. Several processing technologies are available, which will reduce their potentially harmful effects, but will also increase the costs of feeding. Costs and benefits should be considered carefully before deciding which technology to use for specific feedstuffs.

Even if home-grown protein sources are used in an optimum way, it will be necessary to balance the dietary AA pattern by high quality-protein components imported into the farming system. In this respect, beneficial effects can be expected for increasing the methionine content in poultry diets. Frequently, oilseed cakes (expellers) are used for this purpose. Other potential feedstuffs, which may be considered, are yeast and processed milk and egg products. Currently, protein extracts from different plant species, which are available as by-products from the production of plant fibres, are discussed as a potential feed resource for livestock. No scientific data could be found about the use of protein extracts as a component of organic poultry diets.

In contrast to this, the potential advantage of using synthetic methionine for organic poultry seems to be clear. Without a doubt, the formulation of "100 % organic" rations would be simplified if synthetic methionine was allowed to be used in organic livestock. On the other hand, the trend towards more intensive poultry production systems will be fostered by the general use of synthetic methionine (Zollitsch *et al.*, 2004).

Finally, innovative nutritional strategies should be critically assessed in order to solve some of the problems addressed in this paper. In the case of organic laying hens, it can make sense to lower the energy density of the rations. This will increase feed intake (NRC, 1994) which will, in turn, help to maintain AA intake close to the requirement, even if the AA content of typical organic rations is below recommended levels. However, if this strategy is to be used successfully, young chickens and pullets have to be managed in a way that allows them to get used to ingesting greater amounts of feed than in conventional rearing regimes (Baumann, 2004; Joost Meyer, 2004).

In the case of fattening poultry, the influence of unbalanced dietary AA patterns on the quality of poultry meat should be analyzed. For pigs, significant beneficial effects have been shown on meat quality traits (Sundrum *et al.*, 2000).

## **Conclusions**

Several factors have to be considered if deficiencies in the protein supply of organic poultry are to be corrected. Both external and internal resources may help organic poultry farmers to solve these problems: poultry breeding, production of feedstuffs on farm, identification of external high quality feedstuffs, the development and implementation of innovative feeding strategies and consideration of effects on animal

health and welfare, animal performance and product quality have to be linked together in order to derive practical solutions for the problems raised in this paper.

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