Livestock Science 161 (2014) 114–122

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Nutrients deposition and energy utilization in slow-growing broilers fed with organic diets containing graded nutrient concentration

S. Carrasco*, G. Bellof, E. Schmidt

Weihenstephan University of Applied Sciences, D-85350 Freising, Germany

ARTICLE INFO

Article history:
Received 15 April 2013
Received in revised form
2 December 2013
Accepted 30 December 2013

Keywords:
Slow-growing broiler
Protein deposition
Fat deposition
Energy deposition
Metabolizable energy requirement
Organic diets

ABSTRACT

An experiment was carried out to study the growth parameters, body composition, nutrients deposition and energy requirements of male and female slow-growing broilers (ISA J-257) fed with organic diets. Reduced energy (< 12 MJ AME/kg) and essential amino acids (EAA) organic diets were used. A total of 972 1-day old male and female broilers were used and samples of them were weighed and slaughtered at 0, 14, 28, 42 and 56 d of age. The whole-body (WB) was analysed to calculate protein, fat and energy deposition. Gompertz growth parameters for the mentioned variables were estimated; also the energy for maintenance (ME_M) requirements and the efficiencies of energy utilization for fat and protein deposition were determined.

From 28 d of age the WB of males were heavier than females ($P < 0.05$). The dry matter ($P < 0.001$) and fat content ($P < 0.01$) of females were bigger in comparison to males. Diets affected only the dry matter content ($P < 0.01$), thus diets with high AME and EAA (diet 1 and 2) induced large dry matter content in the WB. Males showed a greater potential to deposit protein ($P < 0.001$) from 42 d and energy ($P < 0.05$) at 56 d than females. These results were confirmed with the estimated high growth Gompertz parameters of males and reflected their superior growth potential in comparison to females. Females reached the maximum growth rate (40 d: 45.2 g/d *vs.* 51 d: 60.6 g/d), protein deposition rate (PD) (39 d: 9.0 g/d *vs.* 55 d: 12.7 g/d) and energy deposition rate (ED) (47 d: 502.9 KJ/d *vs.* 56 d: 6787 KJ/d) earlier than males. However, they reached their maximum fat deposition rate (FD) (54 d: 7.8 g/d *vs.* 53 d: 9.3 g/d) one day later. In addition, the maximum growth rate, PD, FD and ED of females were 25.4%, 29%, 16% and 26% lower than those of males. The parameters of the partitioning of ME indicate that males tended to spend more ME on maintenance (ME_M: 540.8 kJ/kg$^{0.75}$/d *vs.* 528.3 kJ/kg$^{0.75}$/d), PD (43.0 *vs.* 41.8 kJ/g) and FD (31.5 *vs.* 31.0 kJ/g) than females. Consequently, they presented slightly lower efficiencies of energy utilization for fat (k_f; 1.2 *vs.* 1.3) and for protein (k_p; 0.5 *vs.* 0.6) than females. These differences between males and females indicate that they do not have the same nutritional requirements. In order to optimize the use of nutrients and to avoid the waste of protein, males and females require individual feeding programs in the organic production of slow-growing broilers.

1. Introduction

The dietary amino acid levels of broiler diets can be maximized according to the organic feed legislation.

* Corresponding author. Tel.: +49 8161 714329; fax: +49 8161 714496.
E-mail address: salocarrasco@hotmail.com (S. Carrasco).

1871-1413/$ - see front matter © 2014 Elsevier B.V. All rights reserved.
http://dx.doi.org/10.1016/j.livsci.2013.12.028

This could be achieved by using less concentrated and low protein diets, which, to a certain extent, may not induce any problems. However, there are conflicting reports: some authors found lower growth rates and inferior carcass composition in broilers fed with more than 3% protein reduced diet, even if all known nutrient requirements are met (Aletor et al., 2000). The fact that broilers fed with low energy diets increase their feed intake was used for an adequate supply with essential amino acids in organic slow-growing broilers in a previous study made by Bellof et al. (2005). Thus, diets with reduced energy level (< 12 MJ/AME/Kg) as well as reduced content of EAA – at a constant ratio of EAA:AME – in the rearing and fattening period lead to an adequate intake of amino acids due to the increased feed intake. As a consequence, a high level of fattening performance and sufficient carcass yield was achieved.

The broiler growth curve and body composition are the result of the interaction between genotype, sex, environmental conditions and degree of maturity. Broiler growth involves nutrient and energy deposition. This knowledge allows us to predict the nutritional requirements, to establish efficient feeding intensity and feeding programs and therefore efficient nutrients utilization with minimal nutrient excretion (Oviedo-Rondón and Waldroup, 2002). The study of broiler nutritional requirements is possible by fitting the broiler growth curve (Gous et al., 1999). The Gompertz function represents the broiler growth and body nutrient deposition accurately (Emmans, 1995; Gous et al., 1999, 2002).

Many studies refer to fast-growing broilers reared in conventional production systems. Nevertheless there is scarce information available on how male and female slow-growing broilers grow when fed with organic diets. That is why they receive the same feeding program in the organic rearing, although males and females have different growth curves and body composition (Grashorn et al., 2012; Sakomura et al., 2005) which in long rearing periods (slow-growing broiler: over 80 d) is more evident. And according to Han and Baker (1993) birds with different body compositions have different nutritional requirements. Therefore the present study is aimed at estimating the WB-weight, WB composition, nutrient deposition and partitioning of the energy in male and female slow-growing broilers fed with low AME and EAA organic diets.

2. Material and methods

The experiment was carried out at the poultry facilities of the University of Applied Sciences Weihenstephan-Triesdorf.

A completely randomized design was used, with two treatments and three replicates per treatment. The treatments were established in a 4×2 factorial arrangement (4 diets and 2 sexes).

972 one-day-old ISA J-257 chicks from an ecologically held parent flock were used and kept according to the specifications of the Council Regulation on organic production of the EEC. Twelve chicks (six males and six females) nearest to the average body weight were slaughtered for initial WB composition analyses (reference group). The remaining chicks were randomly put into 24 pens according to sex (2 sex), diets (4 diets) and replicates (3 replicates), with 40 chicks per pen (approximately 6 m^2/pen). Three chicks from each pen nearest to the pen average body weight were selected every 14 days from 14 to 56 days of age and slaughtered by cervical dislocation while avoiding loss of blood. They were placed in individual plastic bags and kept deep frozen at $-20\,^{\circ}C$ prior to WB analysis. At the same time the feed consumption was registered to study the energy intake.

The initial bedding in each pen consisted of a 10 cm layer of wood shavings onto which straw was subsequently scattered. When the chicks were housed they were put into chicken rings, which were removed after one week so that the whole area of the pen was available to the birds. An outside run was not available to the birds.

The experiment involved two phases: rearing phase (from 1 to 28 days) and fattening phase (from 29 to 56 days). Two diets were tested during the rearing phase and four diets during the fattening phase. The design of the trial is described in Table 1. The diets comprised of different feed mixtures with reduced AME level (< 12 MJ/kg) and reduced content of EAA at a constant ratio of EAA:AME. The amounts of the most important EAA (g amino acids/MJ AME) agreed with the recommendations of the German Society of Nutrient Physiology (GfE, 1999). The EAA:AME ratio of groups 2 and 4 of the fattening phase were reduced to 90% of the GfE recommendations. The composition of the experimental diets is shown in Table 2. All raw materials used for the feed (pellets) were complied with organic standards.

The ingredients and feed mixtures (Table 2) were analyzed for their nutrient contents as well as the most important EAA using conventional analysis methods (Naumann and Bassler, 1988). The energy content of the feed mixtures was carried out according to the estimated equations of the WPSA (1984).

Table 1
Design of the experiment.

Phase	Nutrient	Diet			
Rearing phase		1		2	
(1–28 days.)	AME (MJ/kg)	12.00		11.00	
	Lys/AME (g/MJ)	0.85		0.85	
	Met/AME (g/MJ)	0.31		0.31	
	Lys (g/kg)	10.20		9.35	
	Met (g/kg)	3.72		3.41	
	M+C (g/kg)	7.08		6.49	
	Thr (g/kg)	6.84		6.27	
	Try (g/kg)	1.56		1.43	
Fattening phase		1	2	3	4
(29–56 days)	AME (MJ/kg)	12.40	12.40	11.20	11.20
	Lys/AME (g/MJ)	0.72	0.65	0.72	0.65
	Met/AME (g/MJ)	0.27	0.24	0.27	0.24
	Lys (g/kg)	8.93	8.04	8.06	7.26
	Met (g/kg)	3.35	3.01	3.02	2.72
	M+C (g/kg)	7.69	6.92	6.94	6.25
	Thr (g/kg)	6.82	6.14	6.16	5.54
	Try (g/kg)	1.49	1.34	1.34	1.21

AME=Apparent metabolizable energy (WPSA, 1984), Lys=Lysine, Met=Methionine, M+C=Methionine and Cystine, Thr=Threonine, Try=Tryptophan.