Heat production in broilers is not affected by dietary crude protein

J. Noblet[1], S. Dubois[1], J. van Milgen[1], M. Warpechowski[2] and B. Carré[3]
[1]INRA, UMR1079 SENAH, F35590 Saint Gilles, France
[2]Universidade Federal do Paraná, 88035 Curitiba, Brazil
[3]INRA, UR83 URA, F37380 Nouzilly, France

Introduction

The energy value of poultry feeds is usually estimated according to their metabolisable energy (ME) contents. However, literature indicates that the 'true' energy value of a feed is better estimated by its net energy (NE) content, at least in pigs or polygastric species (Noblet *et al.*, 1994). In the case of poultry, the advantage of NE over ME is less clear and uncertainty remains with controversial conclusions. The objective of the studies reported here was to quantify the efficiency of utilization of ME for NE according to the dietary crude protein (CP) content in order to evaluate the possible interest of proposing a NE system for poultry; complementary studies have been carried out in order to evaluate the effects of fat and dietary fibre on energy utilisation. Indirect calorimetry was used to estimate energy values.

Material and methods

Experimental designs

In trial 1, 8 groups of male broilers were offered a low (LP) or a normal (NP) CP diet (4 groups per diet). Measurements were carried out twice at 3 wk (stage 1) and 6 wk (stage 2) of age. The dietary CP and amino acid levels were adapted according to requirements at each age and levels of limiting essential amino acids were identical in both diets at each stage. Birds were offered feed *ad libitum*; 2 h of darkness was imposed daily. In trial 2, 12 groups of male broilers were offered a NP or a high (HP) CP diet. Measurements were carried out once (6 groups per diet), either at 4 or 5 wk age; the average age was equivalent for both dietary treatments. Feed was offered for 6 periods of 30 min each at 3 h intervals; 6 h of darkness was imposed daily. Due to the high CP level of the HP diet, only the sulphur amino acid content was equivalent in both diets.

The difference in CP level between diets within each trial was about 4.7%. The increase in CP content was achieved by replacing corn starch and free amino acids by soybean protein concentrate. Diets were based on wheat, corn and soybean meal. Birds had *ad libitum* access to water and were kept at 24 °C. Measurements in the open-circuit respiration chamber were conducted for 7 d for groups of broilers kept in a metabolic cage; no feed was provided on the last day to measure the fasting heat production (FHP). Measurements were carried out after at least 7 d of adaptation to the diet and housing conditions. Since the metabolic cage and chamber had a fixed size, the number of birds per group (6 to 15) depended on their age.

Measurements and calculations

Feed intake, BW gain and excreta were measured during 6 d during the fed period. The O_2 and CO_2 gas concentrations in the chamber were used to calculate total daily heat production (HP). Its partitioning between activity-related heat production (AHP; estimated from force sensors on which the metabolic cage was mounted), thermic effect of feeding (TEF) and FHP was obtained using modelling techniques (van Milgen *et al.*, 1997). The ME value of the diet and energy, protein and fat balances were calculated according to standard procedures; balance data were expressed per unit of metabolic body weight (kg $BW^{0.70}$; unpublished data). The NE intake was calculated as: ME intake – TEF – AHP.

Results and discussion

There was no interaction between dietary CP and age for the response criteria. Although essential amino acid supplies were similar for both diets within each trial, BW gain and protein deposition were improved for birds receiving the higher CP diet. Unlike what has been observed in growing pigs (Le Bellego *et al.*, 2001), none of the criteria related to energy utilisation was affected by dietary CP (Table 1). The energy used for physical activity represented about 10% of ME intake. No clear explanations can be given for the higher HP at a lower ME intake in trial 2. Differences in diet characteristics (more dietary fibre, less starch and less fat with subsequent lower ME value in trial 2) could contribute to this difference. In addition, these studies were conducted at a 3 yr interval with genetically different birds. It is unlikely that the difference in feeding techniques (*ad libitum* vs. meals) would generate this difference (unpublished data). In conclusion, the partial replacement of starch by dietary protein in broiler feeds is not associated with changes in energy utilisation.

Table 1. Effect of dietary protein level on energy utilisation in broilers.[1]

	Trial 1				Trial 2			
	LP	NP	RSD[3]	Stat.[3]	NP	HP	RSD[3]	Stat.[3]
Dietary crude protein[2], %	18.0	22.7	-	-	22.5	27.3	-	-
Average BW, kg	1.46	1.47	0.10	NS	1.35	1.34	0.03	NS
Feed intake[2], g/d	142	142	7	NS	142	138	7	NS
Body weight gain, g/d	76	85	8	0.05	78	83	8	NS
Energy balance[4], kJ/kg$^{0.70}$								
ME intake	1609	1609	-	-	1457	1457	-	-
Total HP[2]	853	846	21	NS	892	872	18	0.08
As FHP	450	439	17	NS	419	416	15	NS
As AHP	146	153	21	NS	173	168	12	NS
As TEF	257	256	35	NS	299	288	17	NS
Total energy gain	756	763	21	NS	565	585	18	NS
As protein	331	369	22	0.01	332	369	12	0.01
ME content[2], MJ/kg	13.49	13.52	0.40	NS	12.72	12.64	0.15	NS
NE/ME, %	75.1	74.8	1.7	NS	67.7	68.6	1.3	NS

[1]Abbreviations: ME: metabolisable energy, NE: net energy, HP: heat production, FHP: Fasting heat production, AHP: Activity heat production, TEF: Thermic effect of feed.
[2]Values adjusted for 89% feed dry matter; in trial 1, only values for stage 2 are given (see text).
[3]RSD: Residual standard deviation, Stat.: level of significance (within trial).
[4]Data adjusted for the same ME intake.

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