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Models for predicting energy requirements in meat quail

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ABSTRACT

Three experiments were conducted to determine the metabolizable energy (ME) required for the maintenance (MEm) and growth (MEg) of quail and to develop models for predicting the ME requirements for growing quail. The Exp. 1 was conducted to determine the actual ME of food for quails fed at different levels (ad libitum and 70%, 50%, and 30% of ad libitum intake). Eighty quails in metabolism cages (35-d-old) were assigned to treatments in a completely randomized design (CRD) with 5 replicates of 4 quails each. The average N-corrected apparent ME (AMEn) values obtained were 12.33, 12.15, 12.11, and 13.22 MJ/kg for quails fed ad libitum and 70%, 50%, and 30% of ad libitum intake. The Exp. 2 was conducted to obtain the requirements of MEm, net energy (NE) for maintenance (NEm), and efficiency (k) of energy utilization using the comparative slaughter technique and regression. Six hundred-twenty (15-d-old) were assigned to 4 treatments with 5 replicates of 31 quails each in a CRD. The diet used in Exp. 1 was also offered in Exp. 2. The values obtained for the MEm and NEm, were 659 and 310 kJ/kg$^{0.75}$/d, respectively. The values for the efficiency of fat (kf) and crude protein (kp) deposition and overall efficiency of energy utilization (kfp) and maintenance efficiency (km) were 0.79, 0.32, 0.47, and 0.47, respectively. The Exp. 3 was conducted to determine the MEg requirement. Five hundred (1-d-old) were assigned to 10 slaughter groups (replicates) with 5 groups of 55 quails in each of 2 periods, 0–14 and 14–35 d of age. Quails were slaughtered weekly and the chemical body composition of the quail was determined. The MEg values for the periods 0–14 and 14–35 d of age were 12.2 and 18.8 kJ/g, respectively, which was determined by dividing the NE required for weight gain by the efficiency of dietary ME utilization. The equations for predicting energy demands were determined considering the ME intake (MEI), the metabolic weight of the quails ($W^{0.75}$), and the weight gain per quail/d (G), and prediction equations were MEI$=659W^{0.75}+12.2G$ and MEI$=659W^{0.75}+18.8G$.

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1. Introduction

The determination of nutritional requirements is of great importance for the commercial production of all avian species because diet represents the most burdensome part of production and is perhaps the main factor that determines whether birds will grow to their maximum genetic

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potential. The nutritional requirements of quail are still poorly defined, conflicting, and are often based on extrapolations from requirements of other species of birds, or are obtained from foreign literature such as the NRC (1994). Shrisvastav and Panda (1999) report that these conditions are totally divergent from those found in Brazil.

Most studies related to the determination of nutritional requirements of quail are performed via the dose–response method, and are not based on mechanisms of dietary energy partition necessary for the maintenance, growth, and production of quail. Little is known about the efficiency of energy utilization in regards to the deposition of protein and fat for growth in quails. According to Sakomura et al. (1993), with the use of predictive models, it is possible to determine the energy requirements in specific cases by considering the differences between strains, stage production, regions and seasons; this allows the development of more precise tables of energy requirements for birds.

Information on energy requirements for maintenance and weight gain in quail is scarce in the literature. Predictive models based on factorial methodology have become very useful in studies on energy requirements. Therefore, this study aimed to investigate the energy metabolism of quail by testing maintenance and weight gain so as to develop more adequate nutritional plans for quail through prediction models.

2. Materials and methods

2.1. Experiment 1

2.1.1. Animals, diet and experimental design

The experimental procedure for the three experiments was approved by the Brazilian Animal Ethics Committee. A metabolic assay was performed to determine the metabolizability (ME/GE), the apparent metabolizable energy (AME, kJ/g) and AME corrected to zero *N* balance (AMEn) of experimental diet (Table 1), used in Exp. 2 and 3, provided at 4 feeding levels (ad libitum, and 70%, 50%, and 30% ad libitum).

Eighty unsexed quail (*Coturnix coturnix* sp.) at 35 d of age (average body weight of 220 g) were distributed in a CRD between 4 treatments and 5 replicates, with each replicate containing 4 quails. They were housed in a battery of galvanized wire cages, and supplied with "nipple" type drinkers and feeding troughs.

The experimental period lasted for 12 d. The first five days allowed the quails to adapt to the cages and feed, while total excreta were collected over the next 7 d; ferric oxide (2%) was used as a marker of the beginning and end of the collection period.

Table 1
The composition of the experimental diets given to quail at 2 stages of growth (as-fed).[a]

Item	First stage (0–14 d of age)	Second stage (14–35 d of age)
Ingredient (g/kg)		
Corn	409.5	527.9
Soybean meal (45% CP)	497.5	393.1
Soybean oil	47.5	3.25
Dicalcium phosphate	15.6	16.0
Salt	4.6	4.6
Lime	3.6	2.8
DL-Met	6.7	6.6
L-Lys ≅ HCl	6.8	8.0
L-Thr	4.2	4.1
L-Trp	0.1	0.4
Vitamin and mineral mixture [b]	4.0	4.0
Calculated composition		
ME (MJ/kg)	12.52	12.68
CP (g/kg)	275	235
Ca (g/kg)	6.4	6.1
Available P (g/kg)	4.1	4.1
Na (g/kg)	2.0	2.0
K (g/kg)	10.2	8.6
Cl (g/kg)	3.1	3.1
Digestible Met+Cys (g/kg)	13.2	12.3
Digestible Lys (g/kg)	18.7	17.3
Digestible Thr (g/kg)	12.5	11.1
Digestible Trp (g/kg)	3.0	2.8
Analyzed composition		
DM (g/kg)	884.5	882.6
CP (g/kg)	307.7	268.5
Ether extract (g/kg)	77.6	60.3
GE (MJ/kg)	19.90	19.25

[a] CP=crude protein, ME=metabolizable energy, DM=dry matter, and GE=gross energy.

[b] Provided per kilogram of diet: retinol acetate, 18,000 IU; cholecalciferol, 5000 IU; dl-α-tocopheryl acetate, 16 mg; thiamine hydrochloride, 1.12 mg; riboflavina, 8 mg; pyridoxine hydrochloride, 2.1 mg; cyanocobalamin, 20 mcg; menadione nicotinamide bisulphite, 4.028 mg; D-calcium pantothenate, 16 mg; niacin acid, 40 mg; choline chloride, 560 mg; zinc oxide, 126 mg; ferrous sulfate, 98 mg; manganese sulfate, 155 mg; copper sulfate, 30.624 mg; cobaltous sulfate heptahydrate, 0.4 mg; potassium iodate, 1.936 mg; sodium selenite, 0.508 mg, and butylated hydroxytoluene, 0.02 mg.

2.1.2. Sample processing and laboratory analysis

The cages were lined with trays that were covered with plastic, properly identified, and were removed at each sampling period (12 h apart) for the collection of excreta. The material that was collected after the waste removal of feathers, feed, and peeling skin was frozen and stored until the end of the total collection period. Subsequently, the excreta were thawed, homogenized, weighed, and dried in a forced ventilation greenhouse for 72 h at 55 °C. They were then milled and sent to be analyzed in terms of dry matter (DM) and crude protein (CP). The samples of feed underwent the same analyses, which were performed according to the methodology described by AOAC (1990). The gross energy (GE) was measured using an automatic adiabatic oxygen bomb calorimeter (PARR Instruments CO., PARR 1241, Moline, IL, US). By calculating the difference between the energy consumed and the excreted energy, while also considering the *N* balance, we determined the apparent ME of the diets.

2.2. Experiment 2

2.2.1. Animals, diet and experimental design

To determine the quails' energy requirements for maintenance and the energy efficiencies of fat and protein

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