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Metabolizable Energy Levels for Meat-Type Quails at Starter Phase

Author(s)

Muniz JCL[I]
Barreto SLT[I]
Viana GS[I]
Mencalha R[II]
Reis RS[III]
Hannas MI[I]
Barbosa LMR[I]
Maia RC[I]

[I] Universidade Federal de Viçosa - Departamento de Zootecnia
[II] Universidade Federal de Lavras
[III] Universidade Federal de Sao Joao del-Rei

Mail Address

Corresponding author e-mail address
Jorge Cunha Lima Muniz
Avenida Peter Henry Rolfs, s/n , Viçosa, Minas Gerais 36570-900 - Brazil
Tel: (31) 992263733
Email: jorge.limamuniz@hotmail.com

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ABSTRACT

This experiment was conducted to evaluate the effects of dietary nitrogen-corrected apparent metabolizable energy (AMEn) levels on meat-type quail performance and carcass traits from 1 to 14d of age. A total of 1120 not sexed meat-type quails were randomly distributed to seven treatments, with eight replicates with 20 quails each. A basal corn and soybean meal-based diet was formulated to meet or exceed quail nutritional requirements, except for ME. Graded levels of soybean oil were added to the basal diet in replacement, to sand, to obtain dietary treatments (2,600; 2,700; 2,800; 2,900; 3,000; 3,100 and 3,200 KcalAMEn/kg diet). Data were analyzed as one-way ANOVA and optimum AMEn levels were estimated using polynomial regression model. Increasing in dietary AMEn levels elicited a linear decrease ($p<0.01$) in feed intake and nutrient intake (AMEn, protein and lysine). Quail weight gain and final body weight exhibited a quadratic response ($p<0.03$) to increased AMEn levels, being both optimized at 2820 KcalAMEn/kg diet. Graded AMEn levels elicited a linear increase ($p<0.01$) in carcass dry matter and fat content, whereas moisture content was linearly decreased ($p<0.01$). The protein content of the carcasses was not influenced ($p>0.05$) by AMEn. Based on the results, the dietary AMEn level that warrants adequate performance and carcass traits of meat-type quails from 1 to 14d of age is 2,820 Kcal/kg diet.

INTRODUCTION

In the past, the commercialization of quail meat in Brazil was restricted to the slaughter of male and female Japanese quails, which due to age, had their fertility reduced and therefore, were no longer useful to reproduction. In general, the carcasses had a small size and the meat a poor quality, mainly regarding tenderness. However, over the last years, this scenario has changed due to the introduction of meat-type quails in the Brazilian market. Despite the increasing in meat-type quail production, little research efforts have been put forward on establishing meat-type quail nutritional requirements.

Nutrition is well acknowledged as the major input in production cost, and energy represents the most costly nutrient in poultry diets. Thus, in order to optimize feeding programs, knowing the energy content of feedstuffs as well as establishing the ideal energy intake for poultry is essential to warrant the maximum economic returns (Suida *et al.*, 2001). In general, quail diet formulation is guided by nutritional recommendations from other countries such as NRC (1994) e INRA (1999) recommendations. Despite useful, such literature does not contain recommendations for meat-type quail, but rather for broilers, turkeys and hens (Barreto *et al.*, 2006), which do not allow formulating diets for meat-type quails (Furlan *et al.*, 1996).

Comparing research findings obtained with meat-type quails is difficult since the most part of published literature refers to Japanese quail nutrition (Barreto *et al.*, 2006). Moreover, few information on meat-type quail requirement in the initial (from 1d to 14d) and growing-finishing phase (from 15d to 35d), in separate, are found in literature. The conduction of trials to establish quail nutrient needs is crucial to update the existing tables of quail nutritional requirements. Thus, this study was conducted to estimate the AMEn level for optimum meat-type quail performance and carcass trait in the starter phase.

MATERIALS AND METHODS

All the procedures adopted in this study, involving animal care and use, were previously approved by the Ethics Animal Care and Use Committee of the Universidade Federal de Viçosa (protocol no. 37/2012), which is consistent with the ethical principles of animal experimentation established by the Brazilian College of Animal Experimentation (COBEA, 1991).

Animal husbandry, experimental design, and diets

One-day-old meat-type quails, vaccinated for Marek disease were obtained from a local commercial hatchery and housed in curtain sided room thermally controlled. A total of one thousand one hundred twenty quails (average body weight 9.53g), was randomly assigned into fifty-six 50×50×5 cm (width×length×height) stainless steel cages placed over a masonry countertop (120 cm height), previously covered by wood shavings. Each cage was equipped with one incandescent light, one nipple drinker and one trough feeder, where twenty quails were allotted. A basal diet, based on corn and soybean meal, was formulated to meet or exceed Silva & Costa (2009). Nutritional composition of feedstuffs used in experimental diets corresponded to those described by Rostagno (2011). Experimental treatments (Table 1) consisted of seven levels of

Table 1 – Composition of experimental diets.

	Metabolizable Energy levels (kcal/kg)						
Ingredients	2.600	2.700	2.800	2.900	3.000	3.100	3.200
Corn (7%)	42.343	42.343	42.343	42.343	42.343	42.343	42.343
Soybean meal (48%)	45.563	45.563	45.563	45.563	45.563	45.563	45.563
Inert	7.000	5.863	4.725	3.587	2.450	1.312	0.174
Soybean oil	1.132	2.270	3.407	4.545	5.683	6.820	7.958
Limestone	1.225	1.225	1.225	1.225	1.225	1.225	1.225
Dicalcium phosphate	1.051	1.051	1.051	1.051	1.051	1.051	1.051
Salt	0.384	0.384	0.384	0.384	0.384	0.384	0.384
L-lysine HCl (79%)	0.056	0.056	0.056	0.056	0.056	0.056	0.056
DL-methionine (99%)	0.445	0.445	0.445	0.445	0.445	0.445	0.445
L-triptophan (99%)	0.080	0.080	0.080	0.080	0.080	0.080	0.080
L-isoleucine (99%)	0.118	0.118	0.118	0.118	0.118	0.118	0.118
L-arginine (99%)	0.263	0.263	0.263	0.263	0.263	0.263	0.263
Choline chloride (60%)	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Mineral premixl[1]	0.070	0.070	0.070	0.070	0.070	0.070	0.070
Vitamin premix[2]	0.100	0.100	0.100	0.100	0.100	0.100	0.100
Antioxidant[3]	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Antibiotic[4]	0.010	0.010	0.010	0.010	0.010	0.010	0.010
Coccidiostat[5]	0.050	0.050	0.050	0.050	0.050	0.050	0.050
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated composition							
Metabolizable energy (kcal/kg)	2.600	2.700	2.800	2.900	3.000	3.100	3.200
Crude protein (%)	25.95	25.95	25.95	25.95	25.95	25.59	25.59
Digestible Lys (%)	1.381	1.381	1.381	1.381	1.381	1.381	1.381
Digestible Met + Cys (%)	1.113	1.113	1.113	1.113	1.113	1.113	1.113
Digestible Thr (%)	0.885	0.885	0.885	0.885	0.885	0.885	0.885
Digestible Trp (%)	0.399	0.399	0.399	0.399	0.399	0.399	0.399
Calcium (%)	0.852	0.852	0.852	0.852	0.852	0.852	0.852
Non-phytate phosphorous (%)	0.325	0.325	0.325	0.325	0.325	0.325	0.325
Sodium (%)	0.170	0.170	0.170	0.170	0.170	0.170	0.170

[1]Composition/kg of product: Manganese: 160g, Iron: 100g, Zinc: 100g, Copper: 20g, Cobalt: 2g, Iodine: 2g, inert to achieve 1000 g. [2] Composition/kg de produto: Vit. A:12.000.000 U.I., Vit D3:3.600.000 U.I., Vit. E: 3.500 U.I., Vit B1:2.500 mg, Vit B2: 8.000 mg, Vit B6:5.000 mg, Pantothenic acid: 12.000 mg, Biotin: 200 mg, Vit. K:3.000 mg, Folic acid: 1.500mg, Nicotinic acid: 40.000 mg, Vit. B12: 20.000mg, Selenium: 150 mg, inert to achieve 1.000g. [3] Butyl-hydroxy-toluene. [4] Avilamycin. [5] Salinomycin.

metabolizable energy (2.600, 2.700, 2.800, 2.900, 3.000, 3.100 and 3.200 kcal/kg), which were obtained through graded replacement of sand, by soybean oil. Throughout the feeding trial birds had free access to water and feed. Lighting program consisted of 24 h of light (natural + artificial). The minimum and maximum average daily room temperatures recorded throughout the experiment were 25.30 ± 1.2 and 37.63 ± 2.8, respectively.

Performance and carcass trait measurements

At 14 d of age, birds and feeders were weighed to obtain feed intake (g) and body weight (g). Weight gain (g) was obtained by the difference between the average of the final and initial body weight, whereas feed conversion (g/g) were calculated through the division between feed intake and weight gain. The intake of AMEn (kcal), crude protein (g) and lysine (g) were calculated by multiplying feed intake by the respective concentrations of the afore mentioned nutrients in diets. Mortality was daily recorded to adjust feed intake and feed conversion. After weighing birds and feeders, two birds were selected according to body weight for further carcass trait measurements. After four hours of feed withdrawal period, the selected birds were humanely slaughtered by cervical dislocation between the atlas and the occipital bone. After the slaughter, birds were immediately frozen. Then, frozen samples were ground in an industrial meat grinder, lyophilized and stored for further analyses of carcass composition, according to Silva & Queiroz (2004).

Statistical analysis

Data were analyzed by one-way ANOVA using Sistema para Análises Estatísticas (SAEG, 2007) software package. Ideal AMEn level for performance data assessed was estimated by polynomial (linear or quadratic) regression model. Significant effects were considered when $p \leq 0.05$.

RESULTS AND DISCUSSION

Feed intake exhibited a linear decrease ($p<0.05$) as dietary AMEn levels increased, showing a reduction by 7.50 g for every increase in 100 kcal in AMEn (Table 2). These results support those found by Reis (2010), Ton (2011) and Scherer (2011), who observed a linear decrease in quail feed intake from 1 to 14 d of age in response to increasing dietary AMEn. These findings confirm the hypothesis that, indeed, energy plays an important role in feed consumption; and that poultry tend to regulate feed intake to maintain constant energy intake. Indeed, AMEn is the nutrient responsible for driving feed intake, but excessive energy supply may promote failure in feed intake control (Mbajiorgu 2011). Such assumption may explain the linear decrease ($p<0.05$) in AMEn intake observed in the current study as dietary AMEn increased. As a consequence of the depression in quail feed intake, crude protein and

Table 2 – Growth performance of meat-type quails fed increasing dietary metabolizable energy levels from 1 to 14 d of age.

Item	AMEn (kcal/kg)														CV (%)
	2,600	SE	2,700	SE	2,800	SE	2,900	SE	3,000	SE	3,100	SE	3,200	SE	
FI (g/ave)[1]	154.87	4.29	145.70	6.45	139.36	5.19	130.27	3.15	135.37	3.50	120.54	6.16	102.98	5.49	11.46
MEI (kcal)[1]	402.68	11.15	393.41	17.43	390.22	14.54	377.81	9.13	406.11	10.51	373.70	19.09	329.57	17.56	11.61
CPI (g)[1]	40.19	1.07	37.81	1.61	36.16	1.30	33.81	0.79	35.13	0.88	31.28	1.54	26.72	1.37	11.46
LYSI (g)[1]	2.14	0.06	2.01	0.09	1.92	0.07	1.8	0.04	1.87	0.05	1.66	0.08	1.42	0.08	11.46
BW (g)[2]	87.95	0.60	86.37	1.32	87.05	1.55	88.09	1.50	88.70	1.22	86.53	1.21	82.12	1.24	4.43
WG (g)[2]	78.42	0.63	76.80	1.26	77.69	1.54	78.76	1.45	78.96	1.30	76.80	1.22	72.66	1.16	4.89
FCR (g/g)[1]	1.974	0.05	1.896	0.07	1.792	0.05	1.661	0.06	1.715	0.03	1.567	0.07	1.412	0.06	10.31

Regression equations		
FI = 350.219 - 0.0749951EM		$R^2 = 0.90$
MEI = 633.465 - 0.0867370EM		$R^2 = 0.52$
CPI = 90.8782 - 0.0194599EM		$R^2 = 0.90$
LYSI = 4.83633 - 0.00103561EM		$R^2 = 0.90$
$BW = - 189.062 + 0.196686EM - 0.0000348681EM^2$	E[3] = 2.820	$R^2 = 0.65$
$WG = - 201.355 + 0.198765EM - 0.0000352550EM^2$	E[3] = 2.819	$R^2 = 0.69$
FCR = 4.22451 - 0.000864732EM		$R^2 = 0.94$

Nitrogen-corrected apparent metabolizable energy (AMEn), Feed intake (FI), metabolizable energy intake (MEI), crude protein intake (CPI), lysine intake (LYSI), body weight (BW); weight gain (WG), feed conversion rate (FCR), standard error (SE), coefficient of variation (CV), estimated AMEn level (E);

[1] Linear effect;

[2] Quadratic effect.

lysine intake were also linearly decreased ($p<0.05$) by graded dietary AMEn.

Final body weight and weight gain exhibited a quadratic response ($p<0.05$) to increasing AMEn levels. Optimum body weight (88.30 g) and weight gain (78.80) were reached at 2,820 kcal AMEn/kg diet, which corresponded to an energy-to-protein ratio of 108.60. Similarly, Scherer (2011) verified optimum performance in starter meat-type quails fed energy-to-protein of 108.90. Dietary energy, derived from carbohydrates, lipids, and protein provides conditions for adequate poultry growth. Nevertheless, based on its influence on feed intake, excessive dietary energy supply may limit nutrients intake (e.g. amino acids) and consequently compromise bird performance (Maiorka *et al.*, 2004). In the current study, increasing in dietary AMEn decreased protein and lysine intake, which might explain the quadratic responses observed on FBW and WG.

Starter phase is marked by the immaturity of the gastrointestinal tract, which presents limited nutrient digestion and absorption capacity (Lima 2016). Lipids, in particular, appear to have its digestion and absorption more compromised among nutrients. Reports indicate low pancreatic lipase activity in pre-starter broiler chicks after hatching, which is graded enhanced until 15d of age when it reaches maximum activity (Nir 1993). Macari (2002) reported that broiler chick enterocytes reach total development approximately 2-3 weeks after hatching. Presumably, diets containing higher AMEn levels, due to high soybean oil inclusion, might have supplanted gut capacity of lipids digestion and absorption, which might have contributed to the decrease in BW and WG in quails in the current study. Ton (2011) reported a linear decrease in meat-type quail WG and BW at 14 d of age by increasing dietary AMEn levels from 2,800 to 3,100 Kcal/kg. Contrary to our results, however, Corrêa (2007) did not observe detrimental effects of AMEn levels on 7-to-21-day-old meat-type quail BW and WG by ranging dietary AMEn from 2,900 to 3,100 Kcal/kg.

Feed conversion was linearly improved ($p<0.05$) in response to increasing AMEn levels, decreasing by 0.1 points for every increase in 100 Kcal in AMEn (Table 2). Feed intake decreased 33.50% when dietary AMEn ranged from 2,600 to 3,200 Kcal/kg, whereas the WG was 7.98% lower in birds fed the higher AMEn level. The effects of AMEn in feed intake explain the improvement in feed conversion. On the other hand, Scherer (2011) observed a quadratic response in meat-type quail feed conversion at the initial phase which were optimized at 2,997 kcal/kg.

Dry matter content in quail carcass was linearly increased ($p<0.01$) as AMEn intake increased and hence carcass moisture content decreased ($p<0.01$) as detailed in Table 3. These findings are in agreement with those reported by Scherer *et al.* (2011) for meat-type quails in the initial phase. Contrary to fat deposition, body protein accretion is positively associated with moisture content. Boekholt *et al.* (1994) demonstrated that for each 1g of crude protein retained, approximately an amount of 3g of water was deposited in muscle tissue. The response observed on dry matter content as a function of increasing AMEn levels may be explained by fat content in carcass, which were linearly increased ($p<0.01$) by the increase in dietary AMEn supply. In turn, the increase observed on carcass fat content may be explained by the increase in the energy:protein ratio and as a consequence of the increase in soybean oil inclusion when AMEn content increased. According to Sakomura *et al.* (2004), the inclusion of vegetable oils decrease heat increment

Table 3 – Carcass traits of meat-type quails fed increasing dietary metabolizable energy levels from 1 to 14 d of age.

Item[1]	AMEn (kcal/kg)														CV(%)
	2,600	SE	2,700	SE	2,800	SE	2,900	SE	3,000	SE	3,100	SE	3,200	SE	
DM (%)[2]	23.26	0.62	22.96	0.09	23.23	0.17	25.30	0.37	25.02	0.35	25.15	0.94	25.16	0.36	4.65
M (%)[2]	76.74	0.62	77.04	0.09	76.77	0.17	74.70	0.37	74.98	0.35	74.85	0.94	74.74	0.36	1.49
EE (%)[2]	6.00	0.03	6.09	0.03	5.89	0.03	6.59	0.04	6.21	0.04	6.83	0.04	6.56	0.04	1.74
CP (%)[3]	12.50	0.12	11.54	0.05	12.25	0.08	12.54	0.11	13.03	0.11	11.65	0.56	13.49	0.08	14.80
Regression equations															
DM = 11.6976 + 0.00434911EM															$R^2 = 0.74$
M = 88.3024 - 0.00434911EM															$R^2 = 0.74$
EE = 2.63225 + 0.0012678EM															$R^2 = 0.57$

Nitrogen-corrected apparent metabolizable energy (AMEn),Dry matter (DM), moisture (M), ether extract (EE), crude protein (CP), standard error (SE), Coefficient of variation (CV);

[1] Values on dry matter basis;

[2] Linear effect;

[3] Not significant.

which result in a higher net energy content of diets. Fat deposition is more efficient when the organism uses dietary lipids and endogenous synthesis from glycerol and fatty acids. When fat sources are included in diets, the endogenous synthesis of fatty acids are down regulated, which result in higher amounts of energy available for productive purposes (Franco, 1998).

Protein content in carcass was unaffected (p>0.05) by AMEn concentration in the diets, which are in agreement with Scherer *et al.* (2011). The afore mentioned authors noticed that despite the lower intake of nutrients due to the lower feed intake of quails fed high AMEn levels, meat-type quails reduced body weight but not protein content in carcass. Nutrient intake was indeed lower in quails fed the highest AMEn levels. However, the oil, due to its extra-caloric effect, may have attenuated the reduced nutrient supply by increasing digestibility by increasing digesta retention in gastrointestinal tract (Sakomura *et al.*, 2004; Mateos & Sell, 1981). Such hypothesis was confirmed by Cançado & Baião (2002) who observed an increase in protein digestibility in broilers fed diets with higher oil content compared with birds fed diets without oil.

CONCLUSION

Based on performance and carcass composition, the level of 2,820 kcal AMEn/kg meet meat-type quail requirements.

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