Effect of dietary energy and protein levels on growth performance, carcass yield and some blood constituents of Japanese quails *(Coturnix coturnix Japonica)*

G.M.M. Mosaad and C. Iben

Effekt unterschiedlicher Energie- und Eiweißgehalte im Futter auf die Mast- und Schlachtleistung sowie auf einige Blutparameter bei Wachteln *(Coturnix coturnix Japonica)*

Zusammenfassung

Zweihundertsiebzig Eintagswachtelküken wurden zufällig in 9 Gruppen unterteilt um den Effekt des Energie- und Proteingehaltes im Futter auf die Mastleitung und einige Blutparameter zu testen. Drei Diäten mit 11,0, 11,72 bzw. 12,55 MJ umsetzbarer Energie (ME) je kg und jeweils 21, 24 bzw. 27 % Eiweiß wurden über einen Zeitraum von 6 Wochen verfüttert. Ein linearer Anstieg der Körpermassezunahme konnte mit steigendem Eiweißgehalt beobachtet werden. Der Futteraufwand war in den ersten 3 Wochen bei höheren Eiweißgehalten geringer. Die Stickstoffretention war signifikant höher, wenn die Diät mit hohem Energie- und hohem Eiweißgehalt gefüttert wurde. Totalprotein, Calcium und Phosphor im Serum waren entsprechend den unterschiedlichen Rohproteingehalten im Futter signifikant unterschiedlich. Der Gesamtfettgehalt im Serum erhöhte sich mit steigendem Energiegehalt signifikant ($p < 0,01$).

Schlagworte: Wachtel, Mastleitung, Energiegehalt, Eiweißgehalt, Blutparameter.

Summary

Two hundred and seventy one-day-quail chicks were randomly distributed into 9 treatments to examine the effect of energy and protein levels on their growth performance and some blood constituents. Nine diets containing three levels of metabolizable energy (ME11.0, 11.72 and 12.55 MJ/kg), each at three levels of crude protein (21, 24 and 27 % on DMB) in a 3 x 3 factorial design were fed until 6 weeks of age. There was a linear increase in body weight gain with increased crude protein levels. Feed conversion rate (FCR) and energy efficiency improved in diets with medium and high levels of crude protein during 0–3 weeks of age. Nitrogen retention was significantly higher in the high energy, high protein diet. Total protein, calcium and phosphorus in the serum were significantly different due to the crude protein level. Serum total lipids increased linearly ($p < 0.01$) with dietary energy.

Key words: Quails, fattening yield, energy, protein, blood metabolites.

1 Introduction

Japanese quails *(Coturnix coturnix Japonica)* is a diversified poultry species reared for commercial egg and meat production. It is blessed with the unique characteristics of fast growth, early sexual maturity, high rate of egg production, short generation interval and shorter incubation period that makes it suitable for diversified animal agriculture.

The meat production performance of Japanese quails has also been improved during recent years due to genetic selection. Therefore, there is a need of updating optimal nutritional requirements of Japanese quails with the improvement in genetic make up to exploit production potentiality.

Precise nutrient supply reduces feed cost, wastage of nutrients, environmental pollution, and bad aroma in poultry house, and thus improves animal welfare.

In maize-soyabean meal based diets of growing Japanese quails, methionine, threonine and lysine are the first, second and third limiting amino acids respectively. Generally the crude protein content in diets of growing quails ranges from 24 to 27 % (NRC, 1994; Shrivastava and Panda, 1999; Baldini et al., 1995; Weber and Ried, 1967;

VOHRA and ROUDYBUSH, 1971) that can be reduced through supplementation of the limiting amino acids to the lower levels.

Energy and protein are primary nutritional requirements of all classes of animals and types of production, including growing quails. These requirements must be met before requirements for other nutrients are addressed. The response of growing Japanese quails to different levels of energy and protein for optimal growth performance, feed utilization efficiency, carcass yield and some blood constituents of Japanese quails, were studied herein.

2 Animals, materials and Methods

Two hundred and seventy quail chicks as hatched (average weight 7.63 g ± 0.12) were randomly distributed into nine treatments with three replicates of 10 chicks each, housed in battery cages and kept under similar environmental and managerial conditions during 1–42 days of age. Each cage was equipped with feed and conical water troughs.

Nine diets were formulated with three levels of metabolizable energy (ME; 11.0, 11.72 and 12.55 MJ/kg diet) each at three levels of CP (low, medium and high) in 3 x 3 factorial design. The composition as well as the nutrient content of the experimental diets is shown in table 1. The quails were offered respective experimental diets and water ad-libitum throughout the experimental period. Temperature was set at 35 °C during the first week and gradually reduced by 2.5 °C per week to reach 25 °C at the age of 6 weeks. Synthetic DL-methionine and threonine were used to balance their contents in the ration.

The data of body weight and feed intake were recorded at weekly intervals. Mortality was recorded as and when it occurred. Daily recording of temperature and relative humidity was carried out. Feed conversion (feed, g/g gain) ratio (FCR), energy efficiency (EE: ME intake, kJ/g gain) and protein efficiency (PE: CP intake, g/g gain) were calculated.

A balance trial was carried out for a 3-days collection period during the third week of age. During this period, besides offering weighed quantity of feed, the total excreta voided during a 24-hours period were collected daily and

Table 1: Ingredients (%) and nutrient composition of experimental diets
Tabelle 1: Zusammensetzung (%) und Nährstoffgehalt der Versuchsrationen

Ingredients, %	ME, MJ/kg								
	11.0			11.72			12.55		
	Low P*	Med. P	High P	Low P	Med. P	High P	Low P	Med. P	High P
Yellow corn	52.70	47.30	41.00	55.70	53.00	42.10	57.60	47.20	36.00
Soyabean meal	31.80	41.00	50.20	33.10	42.90	51.50	34.70	43.30	51.81
Wheat bran	12.30	8.70	5.10	6.40	——	——	——	——	——
Dried fat	——	——	1.00	1.60	1.00	4.00	4.60	7.20	10.30
Limestone, ground	1.50	1.45	1.40	1.30	1.20	0.83	0.80	0.56	0.30
Dical. phosphate	0.79	0.80	0.72	1.00	1.16	1.00	1.40	1.00	1.00
Common salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Premix**	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22
DL-Methionine	0.18	0.14	0.10	0.18	0.14	0.10	0.18	0.14	0.11
L-Threonine	0.26	0.14	0.01	0.25	0.13	——	0.25	0.13	0.01
Nutrient composition (on DMB)									
Dry matter, %	89.03	89.03	89.10	89.14	89.10	89.35	89.40	89.51	89.75
ME, MJ/kg	11.08	10.96	10.97	11.72	11.73	11.76	12.58	12.56	12.59
CP, %	21.02	24.02	27.00	21.00	24.00	27.00	21.05	24.02	27.00
ME/CP	0.53	0.46	0.41	0.56	0.49	0.44	0.60	0.52	0.47
Ether extract, %	3.12	2.96	3.32	4.01	3.52	4.98	5.65	6.90	8.38
Crude fiber, %	5.10	5.23	5.36	4.63	4.54	4.99	4.16	4.62	5.08
Calcium, %	0.88	0.89	0.93	0.90	0.90	0.93	0.86	0.86	0.89
Phosphorus, %	0.70	0.71	0.71	0.70	0.71	0.72	0.72	0.71	0.72
Methionine, %	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Threonine, %	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02
Lysine,%	1.07	1.28	1.49	1.08	1.29	1.51	1.10	1.30	1.51

* Protein,** Each kg of premix contained vit. A 8.000.000 IU; vit. D_3 1.600.000 IU; vit. E 7 mg; vit. K_3 1.5 mg ; vit. B_1 1.0 mg ; vit. B_2 3.5 mg; vit. B_6 1.0 mg; vit. B_{12} 10.0 mg; Nicotinic acid 20.0 mg; Pantothenic acid 7.0 mg; Folic acid 1.000.000 IU; Biotin 40.000 IU; Choline chloride 350.0 mg; Mn 40.0 mg; I 0.3 mg; Co 0.75 mg; Zn 40.0 mg; Cu 3.0 mg; Fe 25.0 mg; Se 0.1 mg; Ethoxyquin 5.0 mg and Ascorbic acid 500 mg

weighed. A representative sample of excreta was pooled for 3 consecutive days and dried in a hot air oven at 60 °C till a constant weight was obtained. The dried excreta, feed and residue samples were ground and processed for nitrogen analysis (AOAC, 1995) to calculate the nitrogen retention.

At the end of the experiment three male birds of each replicate were slaughtered after fasting overnight, processed and the weight of carcass, liver, intestine, proventriculus, gizzard, heart and testis were taken and data were expressed as relative weight of live body weight. Blood samples were collected from each treatment. Serum was separated by centrifugation at 3000 rpm for 10 minutes and stored at –18 °C until analysis. Total protein, total lipids, total cholesterol, glucose, calcium and phosphorus were determined according to AGGOOR et al. (2000).

The obtained data were analyzed to study the effect of dietary treatments using three way analysis of variance of the General Linear Model (GLM) of SAS, (1990), while main differences were compared using Duncan's New Multiple Range Test (DUNCAN, 1955).

3 Results and discussion

The results are shown in tables 2 to 6. The composition and metabolizable energy value of the experimental diets are presented in table 1. The performance characteristics of quails fed different energy and protein levels are depicted in table 2. Results showed that the feed intake, body gain and feed conversion ratio did not differ due to the interaction between energy and crude protein levels at any growth phases while feed intake and feed conversion were influenced by CP or energy levels. The live weight gain differed significantly due to CP levels and was not influenced by energy levels. The results in table 3 indicated that protein and energy efficiency did not differ due to the interaction between energy and crude protein levels, but they were influenced by the dietary levels of protein and energy. The nitrogen intake, excreted and retained (g/bird/day) as well as the nitrogen retained % of intake or g per MJME intake were significantly affected ($p < 0.01$) due to interaction of CP and energy levels (table 4). Results in table 5 indicated that there was a

Table 2: Feed intake, live weight gain (g/bird) and feed conversion ratio (g/g weight gain) of growing quails
Tabelle 2: Futteraufnahme, Körpermassezunahme (g/Tier) und Futteraufwand (g/g Zunahme)

100 Items	Feed intake		Live weight gain		Feed conversion ratio	
	0–3 weeks	4–6 weeks	0–3 weeks	4–6 weeks	0–3 weeks	4–6 weeks
Interaction effect						
11.0 MJ – Low P	194.5	371.5	70.38	92.5	2.76	4.02
11.0 MJ – Med. P	218.9	377.5	82.93	82.85	2.64	4.56
11.0 MJ – High P	234.9	399.9	86.54	86.79	2.71	4.61
11.72 MJ – Low P	194.6	317.6	70.79	82.43	2.75	3.85
11.72 MJ – Med. P	208.6	340.2	82.46	84.04	2.53	4.05
11.72 MJ – High P	221.3	372.8	90.28	86.13	2.45	4.33
12.55 MJ – Low P	182.8	301.4	68.67	88.34	2.66	3.41
12.55 MJ – Med. P	189.8	324.5	75.16	96.21	2.53	3.37
12.55 MJ – High P	209.2	350.9	89.3	94.81	2.34	3.70
S.E.M	3.57	4.28	1.33	1.52	0.03	0.11
Main effect						
"Energy"						
11.0 MJ ME	216.1[a]	383.0 [a]	79.95	87.38	2.70 [a]	4.40 [a]
11.72 MJ ME	208.2 [a]	343.5[b]	81.18	84.2	2.56[b]	4.08[b]
12.55 MJ ME	193.9[b]	325.6[c]	77.71	93.12	2.50[b]	3.49[c]
"Crude protein"						
Low	190.6[f]	330.2[f]	69.95[f]	87.76	2.72[d]	3.76[f]
Medium	205.8[e]	347.4[e]	80.18[e]	87.7	2.57[e]	3.99[e]
High	221.8[d]	374.5[d]	88.71[d]	89.24	2.51[e]	4.21[d]
Probability						
ME X CP	NS	NS	NS	NS	NS	NS
ME levels	P < 0.01	P < 0.01	NS	NS	P < 0.01	P < 0.01
CP levels	P < 0.01	P < 0.01	P < 0.01	NS	P < 0.01	P < 0.05

Figures in the same column with different superscript differ significantly linear increase of dressing % with the increase in CP and energy levels, the results also showed that body organs were not affected by the level of both nutrients. Table 6 shows the effect of dietary energy and protein levels on some blood constituents in Japanese quails.

The performance characteristics of quails fed different energy and protein levels are depicted in table 2. Results showed that the feed intake (g/bird) did not differ due to the interaction between energy and CP levels at any growth phase. However, there was a linear increase ($p < 0.01$) of feed intake with the increase in crude protein levels being highest in high CP level. Feed intake differed significantly ($p < 0.01$) due to dietary energy levels, and reduced linearly ($p < 0.01$) with the increase in energy levels during 0–3 or 4–6 weeks of age. These results were in line with those of other workers (ELANGOVAN et al., 2004; KAUR et al., 2008). A higher feed intake with the decrease in dietary energy concentration was to compensate energy intake. The higher feed intake with increased CP levels in this study corroborated well with the earlier observations of KAUR et al. (2006; 2008). This higher feed intake was to compensate energy requirement for growth as the live body weight increased with the CP levels.

The live weight gain (table 3) during 0–3 or 4–6 weeks of age did not differ ($p < 0.05$) due to the interaction of CP and ME levels, while differed significantly due to CP levels. The quails receiving the diet with high CP level (27 %) grew faster ($p < 0.01$) than those reared on medium (24 %) or low (21 %) levels either during 0–3 or 4–6 weeks of age. The dietary energy did not influence the live weight gain at any growth phase. Therefore a dietary level of 11.0 MJ ME/kg and high CP (27 %) during the 4–6 weeks of age was found optimum for body weight gain. The results confirm those observed by ELANGOVAN et al. (2004) and KAUR et al. (2006) in which weight gain of quails did not differ among diets with 11.3 or 12.13 MJ ME/kg during 0–5 weeks or among diets with 11.72–13.39 MJ ME/kg during 0–6 weeks of age (ONYIMONYI and OKEKE, 2000). The

Table 3: Protein and energy efficiency* of growing quails
Tabelle 3: Protein- und Energieaufwand der Wachtelküken

Items	Protein efficiency		Energy efficiency	
	0–3 weeks	4–6 weeks	0–3 weeks	4–6 weeks
Interaction effect				
11.0 MJ – Low P	0.580	0.844	30.62	43.76
11.0 MJ – Med. P	0.633	1.094	28.95	49.96
11.0 MJ – High P	0.732	1.244	29.79	50.54
11.72 MJ – Low P	0.577	0.809	32.22	45.15
11.72 MJ – Med. P	0.607	0.972	29.58	47.48
11.72 MJ – High P	0.662	1.169	28.79	50.88
12.55 MJ – Low P	0.559	0.718	33.47	42.93
12.55 MJ – Med. P	0.606	0.810	31.80	42.38
12.55 MJ – High P	0.633	0.999	29.46	46.61
S.E.M	0.006	0.011	0.293	0.293
Main effect				
"Energy"				
11.0 MJ ME	0.648^{a}	1.061^{a}	29.79	48.33^{a}
11.72 MJ ME	0.615^{b}	0.983^{b}	30.21	47.82^{a}
12.55 MJ ME	0.599^{b}	0.842^{c}	31.59	43.97^{b}
"Crude protein"				
Low	0.572^{f}	0.790^{f}	32.09^{d}	44.18^{f}
Medium	0.615^{e}	0.959^{e}	30.12^{e}	46.61^{e}
High	0.676^{d}	1.137^{d}	29.33^{f}	49.33^{d}
Probability	.			
ME X CP	NS	NS	NS	NS
ME levels	P < 0.01	P < 0.01	NS	P < 0.01
CP levels	P < 0.01	P < 0.01	P < 0.01	P < 0.01

Figures in the same column with different superscript differ significantly
*Protein efficiency (PE) = Protein intake (g)/Weight gain (g); *Energy efficiency (EE) = Energy intake (KJ)/Weight gain (g)

Table 4: Nitrogen metabolism in growing quails at the end of 3rd weeks
Tabelle 4: Stickstoffbilanz der Wachtelküken am Ende der 3. Lebenswoche

Items	N intake g/bird/day	N excreted g/bird/day	N retention g/bird/day	N retention % of intake	N retention g/MJ ME intake
Interaction effect					
11.0 MJ – Low P	0.463^{d}	0.229^{d}	0.234^{c}	50.54^{a}	1.53^{b}
11.0 MJ – Med. P	0.588^{b}	0.325^{b}	0.263^{a}	44.73^{b}	1.57^{b}
11.0 MJ – High P	0.674^{a}	0.403^{a}	0.271^{a}	40.21^{d}	1.58^{b}
11.72 MJ – Low P	0.480^{d}	0.264^{c}	0.216^{d}	45.00^{b}	1.29^{d}
11.72 MJ – Med. P	0.576^{c}	0.322^{b}	0.254^{b}	44.10^{c}	1.44^{c}
11.72 MJ – High P	0.609^{b}	0.345^{b}	0.264^{a}	43.35^{c}	1.59^{b}
12.55 MJ – Low P	0.409^{e}	0.211^{d}	0.198^{e}	48.41^{a}	1.29^{d}
12.55 MJ – Med. P	0.476^{d}	0.255^{c}	0.221^{d}	46.43^{b}	1.65^{c}
12.55 MJ – High P	0.540^{c}	0.275^{c}	0.265^{a}	49.07^{a}	1.69^{a}
S.E.M	0.011	0.006	0.003	0.682	0.04
Main effect					
“Energy”					
11.0 MJ ME	0.575^{f}	0.312^{f}	0.263	45.74^{f}	1.56^{f}
11.72 MJ ME	0.555^{f}	0.310^{f}	0.245	44.14^{g}	1.44^{g}
12.55 MJ ME	0.475^{g}	0.270^{g}	0.205	43.16^{h}	1.47^{g}
“Crude protein”					
Low	0.451^{k}	0.235^{k}	0.216^{k}	47.89^{i}	1.37^{k}
Medium	0.547^{j}	0.301^{j}	0.246^{j}	44.97^{j}	1.47^{j}
High	0.608^{i}	0.341^{i}	0.267^{i}	43.91^{j}	1.62^{i}
Probability					
ME X CP	$P < 0.01$	$P < 0.01$	$P < 0.01$	$P < 0.01$	$P < 0.05$
ME levels	$P < 0.01$	$P < 0.01$	NS	$P < 0.01$	NS
CP levels	$P < 0.01$	$P < 0.01$	$P < 0.05$	$P < 0.01$	$P < 0.01$

Figures in the same column with different superscript differ significantly

quails responded beneficially to high CP level (27 %) which was in line with the earlier feeding trial (KAUR et al., 2006; 2008). A dietary CP level of 26 % was also suggested for better growth and feed efficiency during 0–5 weeks of age in growing Japanese quails (Vogt, 1969).

The interaction of CP and energy levels did not influence feed conversion ratio (FCR) at any growth phase (table 2). However, FCR differed significantly during 0–3 weeks of age due to CP levels, and both during 0–3 and 4–6 weeks of age due to energy levels. The FCR emerged at medium or high CP levels remained statistically similar but was poor in low CP level during 0–3 weeks of age.

The FCR improved linearly ($p < 0.01$) at both the growth phases (0–3 and 4–6 weeks) with the increase of dietary energy level, and the best ($p < 0.01$) FCR was emerged from the diet with 12.55 MJ ME/kg. An improvement in FCR in growing quails with increasing dietary energy levels was also reported earlier (ELANGOVAN et al., 2004).

ATTIA et al. (2006) reported that the growth was increased (5.7 %) when the high energy diet was fed compared to the low energy diet, and resulted in less feed intake (5.8 %) and better FCR (10.8 %) and energy conversion (ECR) ratio (4 %). The improvement of body weight gain, FCR and ECR could be due to the use of fat to increase the energy level and the improvement of digestibility of nutrients.

Findings in this study generally indicated that protein efficiency (EE: protein intake, g/g weight gain) and energy efficiency (EE: ME intake, kJ/g weight gain) did not differ due to the interaction of energy and CP levels (table 3). The quails under high CP level consumed more ($p < 0.01$) protein per unit gain than those on medium or low CP levels during 0–3 and 4–6 weeks of age. No difference existed in PE between the groups fed diets with 11.72 or 12.55 MJ ME/kg, but PE improved linearly ($p < 0.01$) with the increased energy level being the best at 12.55 MJ ME/kg diet. Dietary energy levels did not affect EE (ME intake, kJ per unit gain-EE). An improved FCR and EE with the increased level of CP or amino acids were also observed by

Table 5: Effect of energy and protein levels on dressing % and body organs in Japanese quails
Tabelle 5: Effekt des Energie- und Eiweißgehaltes auf die Ausschlachtungsmasse und die Masse der Organe (%) bei Wachteln

Items	Dressing %	Intestine %	Provent. %	Gizzard %	Liver %	Heart %	Testis %
Interaction effect							
11.0 MJ – Low P	69.32[c]	5.91	0.318	1.90	2.10	1.16	1.25
11.0 MJ – Med. P	71.17[b]	6.08	0.323	1.97	2.18	1.19	1.28
11.0 MJ – High P	72.83[b]	6.13	0.331	2.01	2.26	1.21	1.26
11.72 MJ – Low P	70.18[c]	6.02	0.324	1.89	2.08	1.20	1.32
11.72 MJ – Med. P	71.93[b]	6.18	0.335	2.02	2.23	1.24	1.29
11.72 MJ – High P	73.88[a]	6.21	0.341	2.10	2.31	1.25	1.38
12.55 MJ – Low P	70.38[c]	6.15	0.327	1.98	2.12	1.23	1.27
12.55 MJ – Med. P	71.78[b]	6.23	0.348	2.05	2.20	1.26	1.38
12.55MJ – High P	74.92[a]	6.28	0.361	2.08	2.35	1.27	1.41
S.E.M	0.381	0.09	0.003	0.065	0.043	0.032	0.027
Main effect							
"Energy"							
11.0 MJ ME	71.11	6.04	0.324	1.96	2.18	1.19	1.26
11.72 MJ ME	71.97	6.14	0.333	2.00	2.21	1.23	1.33
12.55 MJ ME	72.36	6.22	0.345	2.04	2.22	1.25	1.35
"Crude protein"							
Low	69.96[c]	6.03	0.323	1.92	2.10	1.20	1.28
Medium	71.63[b]	6.16	0.335	2.01	2.20	1.23	1.32
High	73.88[a]	6.21	0.339	2.06	2.31	1.24	1.35
Probability							
ME X CP	P < 0.01	NS	NS	NS	NS	NS	NS
ME levels	NS	NS	NS	NS	NS	NS	NS
CP levels	P < 0.01	NS	NS	NS	NS	NS	NS

Figures in the same column with different superscript differ significantly

KAUR et al. (2008) and MANDAL et al. (1999) in Japanese quails and guinea fowls, respectively during initial growth period. The EE or energy intake in Japanese quails also did not differ due to diets with variable ME concentrations during 4–7 weeks of age (OLUBAMIWA et al., 1999). The improved EE might be due to the ability of Japanese quails to retain more energy as protein than fat in body tissues in comparison to broiler chickens (SHIM and VOHRA, 1984), which was supported by high essential amino acid level.

The nitrogen intake, excreted and retained (g/bird/day) as well as the nitrogen retained % of intake or g per MJ ME intake were significantly affected ($p < 0.01$) due to interaction of CP and energy levels (table 4). Daily intake and excretion of nitrogen were maximum in quails fed high CP and low energy diet (27 % and 11.0 MJ ME/kg diet, respectively), while N-retention g/bird/day was more in high energy high protein (12.55 Mcal ME/kg diet, 27.0 % CP), medium energy high protein diet (11.72 MJ ME/kg diet, 27.0 % CP), low energy high protein (11.0 MJ ME/kg diet, 27.0 % CP), as well as low energy medium protein (11.0 MJ ME/kg diet, 24.0 % CP) diets. N retention (% of intake) was more ($p < 0.01$) at high energy (12.55 MJ ME/kg diet) with low, medium and high CP levels and at low energy (11.0 MJ ME/kg diet) with low (21.0 %) CP level in comparison with other diets. N-retention (g/MJ ME intake) was higher ($p < 0.01$) in high energy high protein diet. Maximum daily intake of nitrogen in high CP and low energy level corroborated with increased excretion of nitrogen. Again, N-retention per MJ ME intake was better in high CP with high energy diet indicating better utilization of CP in relation to energy intake. The results are in agreement with that obtained by KAUR et al. (2008) in quails fed different energy and protein levels.

The dressing percentage was significantly ($p < 0.01$) different due to the the interaction of energy and protein levels (table 5). There was a linear increase of dressing % with the increase in CP and energy levels being highest in high protein and high energy diet. Our results also showed that body organs (intestine, proventriculus, gizaard, liver, heart, and testis) were not affected by the level of both nutrients. Similarly AL-HARTHI (2002) and ISMAIL et al. (2006) reported

Table 6: Effect of energy and protein levels on some blood parameters in Japanese quails
Tabelle 6: Effekt des Energie- und Eiweißgehaltes auf einige Blutparameter bei Wachtelküken

Items	Total Protein g/dl	Total lipids mg/dl	Cholestrol mg/dl	Glucose mg/dl	Calcium mg/dl	Phosphorus mg/dl
Interaction effect						
11.0 ME – Low P	3.76^{c}	6.12^{c}	254	223	8.22^{d}	3.75^{c}
11.0 ME – Med. P	3.94^{b}	6.19^{c}	259	229	9.21^{c}	4.56^{a}
11.0 ME – High P	4.12^{a}	6.21^{c}	257	231	9.61^{b}	4.65^{a}
11.72ME – Low P	3.81^{c}	6.42^{b}	263	239	8.56^{d}	4.00^{b}
11.72 ME – Med. P	3.97^{b}	6.45^{b}	267	242	9.46^{c}	4.81^{a}
11.72 ME – High P	4.17^{a}	6.53^{b}	264	246	9.95^{b}	4.59^{a}
12.55 ME – Low P	3.79^{c}	6.87^{a}	271	249	9.02^{c}	4.19^{b}
12.55 ME – Med. P	3.92^{b}	6.83^{a}	277	253	9.67^{b}	4.68^{a}
12.55 ME – High P	4.19^{a}	6.91^{a}	278	259	10.57^{a}	4.93^{a}
S.E.M	0.041	0.064	12.0	23.0	0.38	0.19
Main effect						
“Energy”						
11.0 MJ ME	3.94	6.17^{f}	257	228	9.05	4.34
11.72 MJ ME	3.98	6.47^{e}	265	242	9.33	4.46
12.55 MJ ME	3.97	6.87^{d}	275	254	9.77	4.59
“Crude protein”						
Low	3.79^{g}	6.47	263	237	8.59^{g}	3.97^{f}
Medium	3.94^{f}	6.50	268	241	9.46^{f}	4.68^{e}
High	4.16^{e}	6.55	266	245	10.11^{e}	4.74^{e}
Probability						
ME X CP	P < 0.01	P < 0.01	NS	NS	P < 0.01	P < 0.01
ME levels	NS	P < 0.01	NS	NS	NS	NS
CP levels	P < 0.01	NS	NS	NS	P < 0.01	P < 0.01

Figures in the same column with different superscript differ significantly

that increasing energy levels within the range of 11.72–14.23 KJ ME/kg diet for broiler and within the range of 11.30–12.13 KJ ME/kg diet for quails, respectively improved dressing %. Also AGGOOR et al. (2000) found that increasing ME content of the control diet with fat addition produced carcasses of higher dressing %, whilst had no effect on gizaard, liver, giblets, heart and testis (AGGOOR et al., 2000; BADAWY, 1997). On the contrary KASSIM and SUWANPRADIT (1996) and ATTIA et al. (1998) found that increasing dietary ME levels did not affect dressing and internal organs %.

The serum glucose and cholesterol revealed no significant differences attributable to the feeding of different energy and protein levels for Japanese quails (table 7). However, total lipids increased linearly ($p < 0.01$) with the increase in dietary energy. Total protein, calcium and phosphorus in the serum of quails were significantly differed due to the CP level, whilst dietary energy did not affect the serum level of them.

4 Conclusion

It can be concluded, that diets for growing quails calculated on the basis of essential amino acid balance, supported the same production performance regardless of the tested crude protein levels. Implication of amino acids and energy in diets for Japanese quails needs further investigation.

Acknowledgements

We would like to acknowledge the support of Dr. Rudolf Leitgeb.

5 References

AGGOOR, F.A.M., Y.A. ATTIA, and E.M.A. QOTA (2000): A study on the energetic efficiency of different fat sources and levels in broiler chick vegetable diets. J. Agric. Sci. Mansoura Univ. 25, 801–820.

AL-HARTHI, M.A. (2002): Interrelationships among tri-iodothyronine (T3), energy and sex on nutritional and physiological responses of heat stressed broilers. Egypt. Poult. Sci. 21, 349–385.

AOAC (1995): Official methods of analysis. 15th ed., Assoc. Offic. Anal. Chem., Washington DC, USA.

ATTIA, Y.A., F.A.M. AGGOOR, F.S.A. ISMAIL, E.M.A. QOTA, and E.A. SHAKMAK (2006): Effect of energy level, rice by products and enzyme addition on growth performance and energy utilization of Japanese quail. EPC 2006, XII European Poultry Conference, Verona, Italy, September 10–14.

ATTIA, Y.A., M.E. NAWAR, M. OSMAN and S.B. ABDEL-HADY, (1998): Optimum levels of metabolizable energy and crude protein in the rations for Avians-34 broiler chicks. Egypt. J. Anim. Prod. 35, Suppl. Issue, 223–241.

BADAWY, N.A. (1997): Influence of dietary oils on performance, blood lipids and immuno response of Japanese quail. Egypt. Poult. Sci. 17, 53–75.

BALDINI, J.T., R.E. ROBERTS and C.M. KIRKPATRICK (1995): A study of the protein requirements of bobwhite quail reared in confinement in battery brooders to 8 weeks of age. Poult. Sci. 29, 161–166.

DUNCAN, D.B. (1955): Multiple range and multiple F tests. Biometrics 11, 1–42.

ELANGOVAN, A.V., A.B. MANDAL, P.K. TYAGI, P.K. TYAGI, S. TOPPO and T.S. JOHRI (2004): Effects of enzymes in diets with varying energy levels on growth and egg production of Japanese quails. J. Sci. Food Agric. 84, 2028–2034.

ISMAIL, F.S.A., Y.A. ATTIA, F.A.M. AGGOOR, E.M.A.E. QOTA and E.A. SHAKMAK (2006): Effect of energy level, rice by products and enzyme addition on carcass yield, meat quality and plasma constituents of Japanese quail. EPC 2006, XII European Poultry Conference, Verona, Italy, September 10–14.

KASSIM, H. and S. SUWANPRADIT, (1996): The effect of energy levels on the carcass composition of the broilers. Asian J. Anim. Sci., 9, 331–335.

KAUR, S., A.B. MANDAL, K.B. SINGH and R. NARAYAN (2006): Optimizing needs of essential amino acids in diets with or without fish meal of growing Japanese quails (heavy body weight line). J. Sci. Food Agric. 86, 320–327.

KAUR, S., A.B. MANDAL, K.B. SINGH and M.M. KADAM (2008): The response of Japanese quails (heavy body weight line) to dietary energy levels and graded essential amino acid levels on growth performance and immuno-competence. Livestock Sci. 117, 255–262.

MANDAL, A.B., N.N. PATHAK, H. SINGH (1999): Energy and protein requirements of guinea keets (Numida meleagris) as meat bird in a hot-humid climate. J. Sci. Food Agric. 79, 523–531.

NRC, (1994): Nutrients requirements of poultry. 8th ed., Natl. Acad. Press, Washington, DC.

OLUBAMIWA, O., E.S. HARUNA, U. MUSA, T.O. AKINWALE, L.H. LOMBIN and O.G. LONGE (1999): Effect of different energy levels of cocoa husk-based diets on productive performance of Japanese quails. Niger. J. Anim. Prod. 26, 88–92.

ONYMONYI, A.E. and G.C. OKEKE (2000): Protein and energy requirements of the Japanese quail *(Cortunix cortunix japonica)* in the humid tropics. J. Agric. Technol. Educ. 5, 35–38.

SAS Institute, (1995): SAS-User,s Guide: Statistics. Version 6, 4th ed., SAS Institute Inc., Cary, NC., USA.

SHIM, K.F., and P. VOHRA (1984): A review of the nutrition of Japanese quail. World Poult. Sci. J. 40, 261–274.

SHRIVASTAVA, A.K. and B. PANDA (1999): A review of the nutrition of Japanese quail. World Poult. Sci. J. 55, 73–81.

VOGT, H. (1969): Protein requirements of quail chicks in the early stages of rearing. Arch. Gefluegelkd. 33, 274.

VOHRA, P. and P. ROUDYBUSH (1971): Protein requirements of Coturnix quail of 6 weeks of age. Poult. Sci. 50, 1081–1084.

WEBER, C.W. and B.L. REID (1967): Protein requirements of Coturnix quail of 5 weeks of age. Poult. Sci. 46, 1190–1194.

Address of authors

Gamal M.M. Mosaad, Faculty of Veterinary Medicine, Assiut University, Egypt, Department of Animal Nutrition and Clinical Nutrition, Assiut, Egypt
Christine Iben, University of Veterinary Medicine Vienna, Veterinärplatz 1, 1210 Vienna, Austria

Corresponding author
Christine Iben, E-mail: Christine.Iben@vu-wien.ac.at

Eingelangt am 22. April 2009
Angenommen am 3. Dezember 2009