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PROTEIN AND ENERGY REQUIREMENTS OF JAPANESE QUAIL UNDER EGYPTIAN CONDITIONS

1- WINTER SEASON

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ABSTRACT : A total number of 486 unsexed one-week-old Japanese quail chicks and 144 hens (8 weeks of age) were used to determine the energy and protein requirements of growing and laying Japanese quails during the winter season in Egypt (from January to March 2002 where the ambient temperature ranged between 17.5 and 25.8 °C)

Two factorial design experiments (3x3) were conducted. Each experiment included 9 treatment groups. Dietary treatments were formulated to have 3 levels of energy (2800, 2900 and 3000 Kcal ME/kg diet) and 3 levels of protein (22, 24 and 26 % CP) fed during the growing period (1-6 weeks of age). Diets fed during the laying period (8-20 weeks of age) had also 3 levels of energy (2800, 2900 and 3000 Kcal ME/kg diet) and 3 levels of protein (18, 20 and 22% CP).

Results obtained could be summarized as follows:

Experiment 1. At 3 and 6 weeks of age the different energy levels showed consistent higher body weight and daily feed intake for quail chicks fed diets with 2800 and 2900 compared to 3000 K cal ME/kg. While the energy level had no significant influence on daily body weight gain during all the experimental periods. Also, feed intake, feed conversion and mortality rate were not significantly affected by energy level during the whole experimental period (1-6 weeks of age). Protein level had no significant effect on all growth

performance traits and mortality rate during the different experimental periods.

Carcass traits at 6 weeks of age were not significantly affected by the tested levels of dietary energy, protein or their interactions. The best economical efficiency value was recorded by quail chicks fed 2900 Kcal ME /kg with 22% CP from 1-6 weeks of age.

Experiment 2. Results showed that, during the whole experimental period, significant ($P < 0.01$) increase was recorded for egg number, egg mass at the dietary level of 2900 K cal ME/kg compared with other levels, while egg weight and feed conversion values were significantly ($P < 0.01$) improved by feeding hens on diets contained 2900 and 3000 Kcal ME/kg compared with those for hens fed the 2800 Kcal ME/kg dietary energy level. Significant ($P < 0.01$) increase in egg number and significant ($P <0.01$) decrease in egg weight were recorded for layers fed 18% and 20% dietary CP levels, respectively, compared with those fed the 22% CP level. No significant effect was observed in feed conversion values due to dietary protein level effect.

Egg number, egg mass and egg weight were significantly ($P < 0.01$) influenced by the interaction between energy and protein levels examined.

Egg quality characteristics studied were not significantly influenced by the tested levels of protein, energy or their interactions. The best economical efficiency was recorded for hens fed diets contained 2900 Kcal ME/kg with 20% CP during 8-20 weeks of age.

In conclusion, the dietary level of 2900 Kcal ME/kg with 22% CP is recommended for the feeding of growing Japanese quail from 1 to 6 weeks of age while the dietary level of 2900 Kcal ME/kg with 18% CP is recommended for the feeding of layer Japanese quail from 8 to 20 weeks of age during winter season under Egyptian environmental conditions.

INTRODUCTION

The nutrient requirements of Japanese quail are not clear (Yamane et. al; 1978), although several relevant reports have been published. Reports have suggested a requirement for early growth of 25% CP (Voget; 1967, Webor and Reid; 1967). Some studies indicated that coturnix quail can be started on diets containing 25 to 26% protein (Webor and Reid; 1967, Voget; 1967, Lepore and Marks; 1968, Vohra; 1971) and this level can be reduced to 20% after 3 weeks of age (Voget; 1967, Gropp and Zucker; 1968). Recent studies indicated that growth did not differ in the 24% and 20% protein level (Ohguchi et. al. 1997). Whereas contracting results were reported by Abdel-Azeem et. al; (2001); Zeweil 1996 and Abou-Zeid et. al; (2000), they found that feeding growing Japanese quail on a diet contained a high level of protein (24%) led to remarkable improvement of body weight as compared with low protein level (21%). Begin (1967) noted that 20% CP was not enough for laying period while Gropp and Zucker (1968) considered that 16% was sufficient for subsequent egg production.

Kummar et. al., (1978) recommended 22% CP at level of 2900 K cal ME/kg for laying Japanese quail. Shrivastav et. al., (1994) concluded that laying quail performed well when given 19% dietary protein and 2750 Kcal ME /kg and when early diets contained 24 and 20% CP during starter and finisher periods, respectively.

Pinto et. al., (2002) found that the best productive performance obtained when laying quail diets contained 2850 Kcal ME/kg and 22.42 % CP. The following experiments were designed to determine the dietary protein and energy requirements of growing and laying Japanese quail under Egyptian winter conditions

MATERIALS AND METHODS

The present work was carried out at the Experimental Poultry Farm, Poultry Department, Faculty of Agriculture, Zagazig University, Egypt. Two factorial design experiments (3x3) were conducted to determine the CP and energy requirements of growing and laying Japanese quail during winter season in Egypt (from January to March 2002). The maximum and minimum ambient temperatures recorded daily at noon (12:00 pm) ranged between 17.5 and 25.8°C, while, the relative humidity was between 40.7 and 62.4%.

Experiment 1. Growing period (1-6 weeks of age)

A total number of 486 unsexed one-week-old Japanese quail chicks were randomly distributed into nine treatment groups of 54 chicks each with 3 replicates (each of 18 chicks). Chicks of all experimental groups had nearly the same initial average weight.

A (3x3) factorial design experiment was conducted to study the effect of three levels of energy (2800, 2900 and 3000 Kcal ME/kg) and three levels of CP (22, 24 and 26%) on growth performance of Japanese quail during the growing period (1-6 weeks of age). Nine experimental diets were formulated to have 3 levels of energy (2800, 2900 and 3000 Kcal ME/kg) and 3 levels of CP(22,24 and 26%). Each diet was assigned to quails of one of the experimental groups at random. Composition and calculated analysis of the experimental diets are shown in Table 1 . Chicks were grown in brooders with raised wire floors and exposed to 24 hours of constant light. Feed and water were supplied ad libitum through out the experimental period. Individual body weight was recorded at one, three and six weeks of age, feed consumption and mortality rate were recorded during the periods 1-3, 3-6 and 1-6 weeks of age.

At 6 weeks of age three male quails from each treatment group were randomly chosen having average body weight around the treatment mean to study carcass traits. Quails were deprived overnight from feed, weighed and slaughtered. After complete bleeding, feather was removed, then weighed. The carcass traits studied were giblets (liver, gizzard and heart) ,carcass and dressed weight (dressed weight = carcass weight plus giblets weight) / 100g preslaughter weight.

At the end of the experiment, 9 digestibility trials were conducted to obtain the apparent digestion coefficients of each dietary nutrient and to calculate the nutritive values of the experimental diets used. In each trial, 4 birds were housed in individual cage and fed the experimental diets for a period of three days to allow the birds to become adjusted to cages. Then the excreta were quantitavely collected for a 5 days period through which feed intake was also recorded. Chemical analysis of experimental diets and excreta were carried out according to the official methods of AOAC, 1994. Faecal nitrogen was determined according to the methods outlined by Jakobsen et al (1960), while the urinary organic matter fraction was calculated according to Abou-Raya and Galal (1971). Nutritive values were calculated and expressed as total digestible nutrients (TDN) and metabolizable energy (ME). ME was calculated as 4.2 kcal per gram TDN as suggested by Titus (1961).

Data were statistically analyzed on a 3x3 factorial design basis according to Snedecor and Cochran (1982) using the following model:

Yijk= M + Ai + Sj + ASij + eijk

Where : Yijk = an observation, M = the overall mean, Ai = effect of energy level (i=1 to 3), Sj = effect of protein level (j = 1 to 3), ASij = the interaction between energy level and protein level and eijk = random error. Differences among means within the same factor were tested using Duncan's New Multiple Range test (Duncan, 1955)

Experiment 2. Laying period (8-20 weeks of age):

A total number of 144 hens of Japanese quails at 8 weeks of age with nearly equal body weight, and average egg production were randomly divided into nine treatment groups (16 hens in each group). Each group of birds was sub-divided into 8 replicates each of 2 females. Each replicate was housed in one cage. A (3x3) factorial treatment arrangement was performed to study the effect of three levels of energy (2800, 2900 and 3000 Kcal ME/kg) and three levels of protein (18,20 and 22%) on productive performance and egg production of laying Japanese quail during the laying period (8-20 weeks of age). Nine experimental diets were formulated to have three levels of energy (2800, 2900 and 3000 Kcal ME/kg) and three levels of protein (18, 20 and 22%). Each experimental group was fed on one of the experimental diets. Composition and calculated analysis of the experimental diets are illustrated in Table 2. Birds were fed ad-libitum and the fresh water was available all the time during the experimental period.

Artificial light source was used giving a total of 16 hours of light per day through out the experimental period.

The experimental period (8-20 weeks) was divided into three production phases (8-12, 12-16 and 16-20 weeks of age), these phases represented the productive performance of laying curve. Each phase represented data of 4 weeks. For each replicate, egg number and egg weight were recorded daily and feed intake was measured weekly. Egg mass was calculated by multiplying egg number by average egg weight. Feed conversion (kg feed / kg egg) was calculated for each replicate.

Egg quality measurements (shape index , yolk height , albumen height, yolk index, and shell thickness) were determined for every period, at the second and the fourth week of each period according to Shehata (2000). Two eggs were taken randomly from each replicate, being 96 eggs/ treatment

At the end of the experiment, 4 hens from each treatment were used in digestibility trials to determine the apparent digestion coefficient of each dietary nutrient and to calculate the feeding values of the experimental diets. Digestibility trial technique, chemical analysis of experimental diets and excreta and statistical analysis of data obtained followed that used in experiment 1.

The economical efficiency (EEf) of the product (growth rate or egg production) was calculated from the input-output analysis based upon the differences in both growth rate and egg production and feeding cost in growing and laying Japanese quail, respectively (Heady and Jensen, 1954)

RESULTS AND DISCUSSION

Experiment 1. Growing period

Growth performance:

Effect of energy level:

At 3 and 6 weeks of age, the different energy levels studied showed consistent higher body weight of quail chicks received 2800 and 2900 compared to 3000 Kcal ME/kg diet (Table 3).Chicks received 2800 and 2900 Kcal ME/kg up to 6 weeks of age were superior in body weight than chicks received 3000 Kcal ME/kg by 4.13 and 2.55%, respectively. Contradicting results were reported by Attia (1999) and El-Hindawy et. al., (1997) with broiler chicks, they reported that body weight improved due to increase in energy level. Data in Table 3 showed that the different energy levels had no significant effect on daily body weight gain during all periods of the study. These results are in agreement with those reported by Olomu and Offiong (1980) who found no effect of different energy levels on body weight gain in broiler chicks. On the other hand, Mendes and Cury (1987) observed a gradual increase in body weight gain of broiler chicks with increasing dietary energy level from 2900 to 3200 Kcal ME/kg diet.

The average daily feed intake followed nearly the same trend observed with live body weight. Feed intake was significantly ($P<0.05$ or $P<0.01$) higher with 2800 and 2900 energy levels compared to 3000 Kcal ME/kg diet during the starter (1-3 weeks of age) and finisher (3-6 weeks of age) periods, respectively. While feed intake was not significantly affected by energy level during the whole experimental period (1-6 weeks of age). This means that during the starter and finisher periods, the low energy feed was responsible for any increase in feed intake. This may be explained on the basis that chicks require more dietary energy values covered by increasing feed consumption. However, birds have the ability to regulate their energy requirements by increasing feed consumption to certain extent. Coon et. al., (1981) observed that broilers fed a low energy finishing diet consumed significantly more feed than those fed a high energy finishing one. Olomu and Offiong (1980) and Ali (1990) found that feed intake of broiler chicks from 35 to 63 days of age was significantly affected by dietary energy level fed 2800, 3000 and 3200 Kcal ME/kg. Recently, Nahashon et. al., (1995) reported that feed intake was inversely related to dietary energy level.

During the starter (1-3 weeks of age)and finisher (3-6 weeks of age) periods, improved ($P < 0.05$ or $P < 0.01$) feed conversion values were noticed with the higher energy level (3000 K cal ME/kg), while energy level had no significant effect on feed conversion ratios during the whole experimental period (1-6 weeks of age). These results are in good agreement with those reported by Aggor et al (1997), El-Hindawy et al (1997), Attia (1999), Holsheimer and Veerkamp (1992), Coon et al (1981) and Moran (1980), they reported that increasing dietary energy level improved feed conversion in broiler chicks during the finishing period.

Effect of protein level :

Results in Table 3 showed that the different protein levels had no significant influence on all growth performance traits studied (body weight, daily body weight gain, daily feed intake and feed conversion) during the different experimental periods. These results agreed with those of Minoguchi et. al., (2001) who indicated that it is possible to reduce the CP feed level to 22% in Japanese quail diets during the growing period without significant effects on growth and laying performance. Also, Ohguchi et al (1997) found that growth rate did not differ in the 24% and 20% dietary protein level . Contradicting results were reported by Abdel-Azeem et al (2001), Zeweil (1996) and Abou-Zeid et al, (2000) they reported that feeding growing Japanese quail on a diet contained a high protein level (24%) showed a remarkable improvement in body weight and feed conversion ratio as compared with quail received the lower protein level (21% CP). Also, Shalan – Hedaia (1993) found that, increasing protein content in the quail grower diets gradually improved feed conversion ratio and decreased feed intake. In broiler chicks, Dagher (1983) showed insignificant differences among the three levels tested on male weight gains from 6-10 weeks of age. Nahashon et al (1995) and Jacob et al (1995) reported that broiler chicks fed 17% protein diet during 3-6 weeks of age showed insignificant differences in feed intake as compared to 20.5% CP level.

Interaction effects:

Results obtained in this study revealed that all growth performance traits studied were not significantly affected by interaction between energy and protein levels during all the experimental periods except body weight and daily body weight gain at 3 weeks of age (Table 4). Therefore, when taking body weight and daily body weight gain into consideration, it could be concluded that the level of 2900 Kcal ME/kg diet along with 22% CP would be suitable till 3 weeks of age while 2800 Kcal ME/kg diet with 26% CP would be reasonable for chickens from 3 to 6 weeks of age.

Mortality rate during the whole experimental period (1 – 6 weeks of age) was not significantly affected by energy level, protein level or their interactions (Tables 3 and 4).

Economical efficiency (EEf):

Data presented in Table 3 showed that chicks fed the diet contained 2900 Kcal ME/kg recorded the best EEf value as compared with other energy levels. Whereas EEf value tended to decrease with increasing protein level in the diet from 22 to 26% (Table 3).

The results of economical efficiency (Table 4) indicated that the best EEf was recorded by quail chicks fed 2900 kcal ME/kg with 22% protein up to 6 weeks of age.

Digestibility coefficients of the experimental diets:

Effect of energy level:

Data presented in Table 5 showed that dietary energy level exerted significant effect ($P<0.05$ and $P<0.01$) on digestibly of CP, EE. NFE & OM. Increasing the dietary energy level almost decreased the digestibly of DM CP, EE. and OM, whereas it increased CF and NFE digestibility. The differences were mostly significantly. However, Attia (1999) found that the high energy diets showed significant increase in the digestion coefficients of DM , OM and EE compared with the low energy ones. Aggor et al, (1997) reported that increasing dietary energy in broiler chicks decreased protein digestibility.

Effect of protein level:

Step up the CP level (22 to 26%) in quail grower diets resulted significant ($P < 0.05$ or $P < 0.01$) effect on digestion coefficients of the all nutrients (Table 5). It is clear that digestion coefficients of DM, CP, NFE and OM with the lowest dietary protein level (22%) were better than those of the other dietary protein levels tested. These results are in agreement with those reported by Aggor et al, (1997) and Ghazalah et al (1988), they found that increasing CP level decreased protein digestibility.

Interaction effects:

Results in Table 5 showed significant ($P < 0.01$) interaction effects due to energy and protein levels on digestion coefficients of EE, NFE and OM. When taking digestion coefficients of OM into consideration, the energy level of 2900 K cal ME/kg along with 22% CP resulted the highest digestion coefficient values.

It is of great importance to note that results of the digestion coefficients were coincided generally with those of the growth performance and feed conversion efficiency.

Nutritive values:

The nutritive values (TDN and ME) were significantly (P<0.05 and P<0.01) influenced by the three dietary energy and protein levels tested and their interaction (Table 5).

TDN and ME values were decreased by increasing both the dietary energy level (2800 to 3000 Kcal ME/kg)and protein level (22 to 26%).

Carcass traits:

Results in Table 6 did not show any significant effect on all carcass traits of growing Japanese quail due to the different dietary energy and protein levels or their interactions. These results agreed partly with those obtained by Hasanien (1995) who found that energy level (2600 to 3000 Kcal ME/kg) had insignificant effect on total edible parts percentage of 6 weeks old growing quail. El-Nagar et al (1997) and Cable and Waldroup (1991) reported that CP and energy levels had no significant effect on carcass dressing percentage of 56-day-old broiler chicks. Moreover, Sherif (1980) found that CP level had insignificant effect on giblets and viscera percentages, also on internal organs (Droboklavova, 1981).

Experiment 2. Laying period:

Productive performance:

Effect of energy level:

Results in Table 7 showed that a significant (P < 0.01) increase for egg number and egg mass during all experimental periods at the level of 2900 K cal ME/kg diet as compared with the other levels. These results disagreed with those observed in Japanese quail by Shrivastav et. al., (1994) who reported that percent hen-day egg production and egg mass were not influenced by tested levels of dietary energy. Similar results were noticed in chicken by Saxena et. al., (1986). Hasanien (1995) indicated that energy level of 2800 Kcal ME/kg diet was the best for egg number and egg production percent in Japanese quail.

Layers fed diets with 2900 and 3000 Kcal ME/kg exerted significant ($P<0.05$)improvement in both egg weight and feed conversion values (except at 8-12 weeks for feed conversion) compared with those fed the 2800 Kcal ME/kg dietary energy level. In partial agreement with results obtaind, Hasanien (1995) found that the best feed conversion was recorded for quail fed the energy level of 2800 Kcal ME/kg followed by those fed the energy levels of 3000 and 2600 Kcal ME/kg diet. But our results disagreed with those obtained by Murakami et. al., (1993) who found that egg weight and feed conversion of quail decreased linearly with increasing dietary energy level.

Effect of protein level:

Data in Table 7 showed significant ($P<0.01$) increase in egg number and significant ($P<0.01$) decrease in egg weight for layers fed 18 and 20% dietary CP levels compared with those of layers fed the 22% CP level during all the experimental periods except egg weight at 8-12 weeks. These results are in agreement with those obtained by Mattos et al (1999) and Murakami et al (1993), they found that mean egg weight in Japanese quail increased significantly with increasing protein level (22 and 25% respectively). While Shrivastav et al (1994) reported that egg weight decreased with increasing protein level, the weight with 22% protein level was significantly lower than with the other 2 protein levels (19 and 22% respectively)

No significant influence was observed in egg mass and feed conversion values due to effect of the tested levels of dietary protein during all the experimental periods except in egg mass at 16-20 weeks of age. These results agreed with those observed in Japanese quail by Shrivastav et al (1994) who found that egg mass expressed as total weight of eggs produced was unaffected by dietary protein levels.

Interaction effects:

Egg number, egg weight and egg mass were significantly ($P<0.01$) influenced by the interaction between energy and protein levels tested (Table 8). Taking egg number, egg weight and egg mass into consideration, the level of 2900 Kcal ME/kg along with 22% CP are suitable from 8 to 20 weeks of age for layer quail for productive performance.

However, Murakami et al (1993) indicated that CP and ME requirements of Japanese quail during the laying period were 18% CP and 2700 Kcal ME/kg, respectively. While, Shrivastav et al (1994) concluded that quail performed well when given 19% dietary protein and 2750 Kcal ME/kg. Pinto et al (2002) showed that, to obtain the best productive performance, the quail diets should be contain 2850 Kcal ME/kg and 22.42% CP.

Data in Tables 7 and 8 did not show any significant effect due to energy level, protein level and their interactions during the period from 8 to 20 weeks of age.

Economical efficiency:

Results in Table 7 indicated that hens fed the diet contained 2900 Kcal ME/kg provided higher EEf value during the whole experimental period than those fed the diet contained 2800 or 3000 Kcal ME/kg.

The best EEf value was recorded for birds fed the 20% dietary CP level compared with the other two levels (18% and 22%). However, hens fed the diet contained 2900 Kcal ME/kg with 18% CP recorded the best EEf value during 8-20 weeks of age (whole experimental period).

Digestibility coefficients of the experimental diets:

Effect of energy level:

Data in Table 9 showed that DM, EE, NFE and OM digestibility values were significantly ($P<0.05$) affected by dietary energy levels and non significantly in case of CP and CF. It is clear that , increasing the dietary level almost decreased the digestibility of DM,EE and OM, whereas it increased NFE digestibility. Attia (1986) found that increasing dietary energy level decreased protein digestibility in white leghorn strain.

Effect of protein level:

Step up the CP level (18 to 22%) in quail layer diets resulted significant ($P < 0.05$ or $P < 0.01$) effect on digestion coefficients of the all nutrients (Table 9). It is clear that digestion coefficients of DM,CF,NFE and OM with the lowest dietary protein level(18%) were better than those of the the other dietary protein levels tested. Attia (1986) also found that increasing dietary protein level in White Leghorn strain decreased protein digestibility.

Table 1. Composition and calculated analysis of grower quail diets.

Protein level, %	22			24			26		
Energy level, K cal ME/kg	2800	2900	3000	2800	2900	3000	2800	2900	3000
Ingredients									
Yellow corn	57.55	60.98	63.00	54.11	57.25	58.67	51.80	51.94	52.70
Wheat bran	5.00	0.00	0.00	4.00	0.00	0.00	3.00	0.00	0.00
Corn gluten 60%	4.00	5.00	7.00	5.50	6.00	10.00	7.00	8.00	11.00
Soy bean meal 44%	28.00	29.50	23.10	30.10	30.10	24.60	32.10	33.10	29.00
Fish meal 72%	2.00	1.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Cotton seed oil	0.00	0.00	0.35	0.00	0.40	0.40	0.00	0.80	1.20
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Dicalcium phosphate	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
L-Lysine	0.13	0.18	0.26	0.04	0.03	0.16	0.00	0.00	0.00
D-L Methionine	0.21	0.22	0.16	0.13	0.12	0.07	0.07	0.04	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis**									
C.P%	22.04	21.90	22.08	24.02	24.10	24.04	26.00	25.96	26.05
ME Kcal/Kg	2804	2913	3011	2827	2922	3008	2834	2930	3006
C/P ratio	127.45	132.41	136.86	117.79	121.75	125.33	109.00	112.69	115.62
Ca%	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
P%	0.42	0.40	0.44	0.45	0.44	0.47	0.46	0.46	0.48
Lysine %	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.40	1.40
Methio.+Cyst. %	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Price/ton diet,L.E.***	955.00	967.00	1006.0	969.00	978.50	1006	1055	1099	1105

* Grower Vit. & Min. premix: Each 2.5kg consists of: Vit. A 12000.000 IU; Vit. D3, 2000.000 IU; Vit. E, 10g; Vit k3, 2g; Vit B1, 1000mg; Vit B2, 4g; Vit B6, 1.5g; Vit B12, 10mg; Pantothenic acid, 10g; Niacin, 20g; Folic acid, 1000 mg; Biotin ,50mg; Cholin chloride, 500g; Fe, 30g; Mn, 40g; Cu, 3g; Co, 200mg; Si, 100mg and Zn, 45g.

** Calculated according to NRC (1994).

*** Calculated according to the price of feed ingredients when the experiment was started.

Table 2 Composition and calculated analysis of layer quail diets.

Protein level, %	18			20			22		
Energy level ,K cal ME/kg	2800	2900	3000	2800	2900	3000	2800	2900	3000
Ingredients									
Yellow corn	64.25	64.25	62.85	58.45	59.25	57.45	55.15	53.20	52.94
Soy bean meal 44%	24.10	20.10	19.00	28.00	22.10	22.10	28.00	27.75	24.00
Corn gluten 60%	3.00	6.00	7.00	4.40	8.70	9.00	8.00	8.60	11.30
Cotton seed oil	0.00	1.00	2.50	0.70	1.50	3.00	0.50	2.10	3.48
Salt	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Premix*	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Limestone	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.50
Dicalcium phosphate	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
L-Lysine	0.25	0.35	0.35	0.15	0.25	0.25	0.15	0.15	0.18
D.L-Methionine	0.30	0.20	0.20	0.20	0.10	0.10	0.10	0.10	0.00
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis **									
CP%	18.10	18.08	17.97	20.10	20.13	20.07	21.95	22.03	22.15
ME Kcal/Kg	2804	2911	3006	2802	2920	3005	2800	2904	3014
C/P ratio	155.78	161.72	167.00	140.10	146.00	150.25	127.27	132.00	137.00
Ca%	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60	2.60
P%	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Lysine %	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Methio.+Cyst. %	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Price/ton diet, L.E ***	900.00	931.00	967.00	924.00	954.00	987.00	943.00	982.50	1008.0

* * Layer Vit. & Min. premix : Each 2.5kg of vitamin and mineral premix (commercial source pfiezer co.) contains: Vit A. 12 Miu., E. 15 IU., Vit. D3 4 Miu., Vit. B1 1 g, Vit. B2 8g, pantothenic acid 10.87g, Nicotinic acid 30g, Vit. B6 2g, Vit. B12 10 mg. Folic acid 1g, Biotin 150 mg, Copper 5g, Iron 15 g, Manganese 70g, Iodine 0.5 g, Selenium 0.15g, Zinc 60g, Antioxidant 10g.

** Calculated according to **NRC (1994)**.

*** Calculated according to the price of feed ingredients when the experiment was started.

Table 3. Growth performance (X ± SE) of Japanese quail chicks as influenced by energy and protein levels during the experimental periods.

Factors	Energy level (Kcal ME /kg)				Protein level (%)			
	2800	2900	3000	Sign	22	24	26	Sign
Body weight (g)								
1 week	19.8±0.544	19.7±0.338	19.3±0.336	NS	19.9±0.362	19.5±0.206	19.5±0.057	NS
3 weeks	88.1±6.408^{a}	86.9±10.734^{a}	83.1±7.226^{b}	**	87.3±11.133	84.3±10.907	86.5±3.592	NS
6 weeks	191.6±10.140^{a}	188.7±7.590^{ab}	184.0±4.366^{b}	*	186.9±3.361	186.8±3.885	190.6±7.564	NS
Daily body weight gain (g)								
1-3 weeks	4.6±0.718	4.5±0.734	4.3±0.255	NS	4.5±0.448	4.3±0.706	4.5±0.479	NS
3-6 weeks	4.9±0.184	4.9±0.229	4.8±0.381	NS	4.7±0.405	4.9±0.344	4.9±0.110	NS
1-6 weeks	4.8±0.273	4.7±0.212	4.6±0.123	NS	4.6±0.087	4.6±0.107	4.7±0.207	NS
Daily feed intake (g)								
1-3 weeks	12.5±0.967^{a}	12.1±1.025^{ab}	11.4±0.904^{b}	*	12.1±1.230	12.2±1.101	11.7±0.990	NS
3-6 weeks	20.3±1.365^{a}	19.4±1.898^{a}	18.1±0.637^{b}	**	19.9±2.650	19.3±2.086	18.5±1.520	NS
1-6 weeks	17.4±1.717	17.0±1.314	16.8±1.612	NS	17.5±1.615	16.9±1.801	16.9±1.807	NS
Feed conversion								
1-3 weeks	3.38±0.401^{b}	2.83±0.152^{a}	2.56±0.141^{a}	*	3.26±0.111	2.73±0.206	2.77±0.528	NS
3-6 weeks	4.26±0.307^{b}	4.02±0.530^{b}	3.65±0.272^{a}	**	4.02±0.837	4.06±0.698	3.85±0.374	NS
1-6 weeks	3.79±0.157	3.66±0.213	3.53±0.055	NS	3.70±0.170	3.59±0.099	3.68±0.314	NS
Mortality rate								
1-6 weeks	4.94±1.400	2.47±1.091	2.41±1.704	NS	4.62±1.132	3.70±2.012	1.23±1.417	NS
Economical efficiency								
1-6 weeks	1.681	1.725	1.698	-	1.801	1.796	1.508	-

Means in the same row within each classification bearing different letters are significantly ($P<0.05$) different.
* $P< 0.05$, ** $P< 0.01$ and NS = not significant

Table 4. Growth performance (X ± SE) of Japanese quail chicks as affected by interaction between energy and protein levels during the experimental periods.

Energy level, Kcal ME/kg	2800			2900			3000			Sign
Protein level,%	22	24	26	22	24	26	22	24	26	
Body weight (g)										
1 week	20.2±0.67	19.5±0.23	19.8±0.23	20.1±0.17	19.6±0.32	19.5±0.19	19.2±0.12	19.3±0.08	19.2±0.09	NS
3 weeks	88.2±3.33a	91.7±1.01ab	84.5±1.90abc	93.3±2.79ab	80.7±0.74b	86.6±0.63a	80.4±5.57b	80.6±4.21b	88.4±1.67a	**
6 weeks	189.8±6.16	191.7±2.89	193.2±4.28	190.2±1.10	185.9±4.91	190.1±1.52	180.7±0.67	182.8±4.20	188.5±5.10	NS
Daily body weight gain(g)										
1-3weeks	4.5±0.20a	4.8±0.06ab	4.3±0.12abc	4.9±0.15ab	4.1±0.05b	4.5±0.05a	4.1±0.37b	4.1±0.27b	4.6±0.11a	*
3-6weeks	4.8±0.24	4.7±0.26	5.2±0.23	4.6±0.10	5.0±0.21	4.9±0.01	4.8±0.13	4.9±0.07	4.8±0.28	NS
1-6weeks	4.7±0.18	4.8±0.03	4.8±0.02	4.7±0.07	4.6±0.14	4.7±0.11	4.5±0.11	4.5±0.04	4.7±0.14	NS
Daily feed intake (g)										
1-3weeks	12.1±0.10	13.1±0.11	12.2±0.20	13.0±0.10	11.6±0.08	11.7±0.201	11.1±0.09	11.9±0.20	11.2±0.10	NS
3-6weeks	20.9±0.99	20.6±0.17	19.4±0.73	20.6±0.99	18.9±0.37	18.6±0.558	18.1±0.45	18.4±0.34	17.7±0.33	NS
1-6weeks	17.9±1.01	17.3±1.00	17.1±0.99	17.3±1.04	16.5±0.81	17.3±0.914	17.2±0.71	16.8±0.61	16.4±0.55	NS
Feed conversion										
1-3weeks	3.38±0.080	2.83±0.069	2.56±0.34	2.75±0.07	2.87±0.03	2.86±0.09	2.62±0.02	2.72±0.03	2.34±0.02	NS
3-6weeks	4.31±0.125	4.48±0.179	4.00±0.30	4.26±0.13	3.97±0.20	3.82±0.10	3.50±0.09	3.73±0.08	3.73±0.17	NS
1-6weeks	3.96±0.120	3.67±0.097	3.72±0.12	3.62±0.16	3.56±0.24	3.80±0.07	3.51±0.20	3.55±0.04	3.51±0.21	NS
Mortality rate										
1-6 weeks	9.26±2.42	5.56±2.13	0.00±0.00	1.85±1.71	3.70±2.25	1.82±1.91	3.80±1.41	1.83±2.218	1.85±1.33	NS
Economic efficiency										
1-6 weeks	1.764	1.814	1.465	1.857	1.852	1.466	1.781	1.723	1.592	-

Means in the same row within each classification bearing different letters are significantly ($P<0.05$) different.
* $P < 0.05$, ** $P< 0.01$ and NS = not significant

Table 5. Digestibility coefficients and nutritive values of growing Japanese quails during winter season.

Dietary treatments		Digestibility coefficients (%)						Nutritive values (as fed)	
Energy level, Kcal ME /kg	Protein level (%)	DM	CP	EE	CF	NFE	OM	TDN (%)	Kcal ME /kg
2800		70.4±2.25	85.0 ± 0.38^{a}	70.8 ± 1.13^{a}	29.7±1.54	77.6 ± 0.48^{a}	71.6 ± 0.70^{a}	70.0±0.40b	2941.4±16.99b
2900		67.3±1.90	83.2 ± 0.40^{b}	69.2 ± 1.03^{a}	31.5±1.81	75.9 ± 0.31^{b}	69.3 ± 0.76^{b}	69.2±0.60a	2909.2±14.21a
3000		64.4±2.71	83.6 ± 0.08^{b}	64.8 ± 0.99^{b}	30.7±2.00	78.1 ± 0.81^{a}	69.4 ± 0.42^{b}	65.6±0.31a	2787.7±12.91a
Significance		NS	**	**	NS	**	*	**	**
	22	70.9 ± 1.54^{a}	83.7 ± 0.44^{a}	64.5 ± 1.21^{b}	29.4 ± 1.52^{b}	80.7 ± 0.0^{a}	73.2 ± 0.80^{a}	69.1±0.31a	2902.0±15.09a
	24	68.9 ± 0.91^{ab}	84.0 ± 0.51^{a}	69.2 ± 0.77^{a}	33.3 ± 0.99^{b}	75.4 ± 0.21^{b}	69.7 ± 0.51^{b}	68.2±0.41b	2867.3±15.09b
	26	64.2 ± 2.01^{b}	82.1 ± 0.21^{b}	70.3 ± 1.21^{a}	36.9 ± 1.00^{a}	75.5 ± 0.81^{b}	65.2 ± 0.90^{c}	68.2±0.70b	2868.3±17.21b
Significance		*	*	**	*	**	**	*	*
2800	22	70.5±3.90	86.1±0.67	66.1±1.96a	32.0±1.68	78.7±0.83a	72.0±1.21a	67.4±0.70a	2828.8±29.4a
	24	71.9±3.01	85.4±0.60	70.6±1.81ab	31.8±1.30	78.8±0.91ab	73.2±1.01ab	66.0±0.61ab	2773.0±25.4ab
	26	68.7±2.21	83.5±0.51	67.1±2.03abc	36.4±2.07	76.3±0.09abc	69.8±2.10abc	65.8±.0.81ab	2761.5±30.0ab
2900	22	73.7±1.90	83.9±0.80	70.2±0.99abcd	29.7±3.00	81.4±1.08a	74.8±0.99abc	70.5±1.01abc	2959. 0±31.3abc
	24	66.4±0.89	82.8±0.42	68.4±1.01ab	31.8±2.51	74.6±0.92b	67.9±0.82abcd	68.9±2.00abcd	2894.3±26.2abcd
	26	64.9±0.99	81.8±0.71	67.6±2.17a	34.3±1.08	76.6±0.61a	64.3±1.01abc	68.4±1.81ab	2873.8±24.9ab
3000	22	68.5±3.17	82.2±0.32	63.2±0.918ab	28.9±2.017	80.1±1.00a	70.8±1.11a	69.5±0.90abcdf	2920.1±27.7abcdf
	24	65.6±2.13	83.8±1.03	60.8±2.406a	33.2±0.897	76.7±1.10b	68.1±2.30b	69.8±0.69b	2934.7±29.0b
	26	63.4±3.72	84.0±0.69	68.2±1.904b	35.8±1.604	77.5±0.84a	65.2±0.81a	70.7±0.80a	2969.4±28.6a
Significance		NS	NS	**	NS	**	**	**	**

Means in the same column within each classification bearing different letters are significantly ($P<0.05$) different.

* $P<0.05$. ** $P<0.01$ and NS = not significant

Table 6. Some carcass traits of growing Japanese quails (g/100 body weight) as influenced by energy level, protein level and their interactions.

Dietary treatments					
Energy level, kcal ME/kg	Protein levels (%)	Preslaughter weight	Carcass %	Giblets %	Dressing %
2800	-	172.2 ± 2.29 b	79.9 ± 0.61	5.9 ± 0.24	85.8 ± 0.31
2900	-	180.2 ± 3.71 a	79.5 ± 0.81	5.5 ± 0.19	85.0 ± 0.29
3000	-	181.7 ± 2.61 a	79.6 ± 0.44	5.4 ± 0.30	85.0 ± 0.40
Significance		*	NS	NS	NS
	22	182.3 ± 4.01	79.5 ± 0.55	5.8 ± 0.27	85.3 ± 0.19
	24	176.3 ± 2.51	79.5 ± 0.70	5.6 ± 0.19	85.1 ± 0.31
	26	175.6 ± 3.71	79.6 ± 0.61	5.5 ± 0.20	85.1 ± 0.37
Significance		NS	NS	NS	NS
2800	22	178.9 ± 3.97	79.6 ± 1.06	6.6 ± 0.42	86.2 ± 0.61
	24	170.5 ± 3.12	80.5 ± 1.20	5.7 ± 0.39	86.2 ± 0.50
	26	167.3 ± 2.51	79.6 ± 0.79	5.6 ± 0.61	85.2 ± 0.70
2900	22	182.2 ± 3.21	79.9 ± 1.12	5.0 ± 5.41	84.9 ± 0.59
	24	173.2 ± 3.01	79.7 ± 1.71	5.8 ± 0.50	85.5 ± 0.80
	26	185.3 ± 4.21	78.9 ± 1.41	5.6 ± 0.44	84.5 ± 0.66
3000	22	185.7 ± 3.31	78.8 ± 1.21	5.7 ± 0.61	84.5 ± 0.44
	24	185.3 ± 2.91	79.0 ± 0.99	5.3 ± 0.70	84.3 ± 0.57
	26	174.2 ± 3.51	81.1 ± 1.07	5.2 ± 0.39	86.3 ± 0.64
Significance		NS	NS	NS	NS

Means in the same column within each classification bearing different letters are significantly ($P<0.05$) different

* $P< 0.05$ and NS = not significant.

Table 7. Productive performance (X±SE) of Japanese quail layers as affected by energy and protein levels during the experimental periods.

	Energy level (Kcal ME/kg)				Protein level (%)			
	2800	2900	3000	Sign	18	20	22	Sign
Body weight (g)								
8 weeks	198.8±2.79	196.6±1.00	195.2±8.78	NS	197.7±1.22	195.6±10.04	197.5±4.23	NS
12 weeks	200.5±14.33	196.5±15.61	203.9±3.66	NS	201.3±11.23	197.34±12.90	202.4±16.66	NS
16 weeks	210.5±29.00	214.2±5.38	218.9±8.45	NS	213.4±7.52	209.1±22.72	221.0±8.46	NS
20 weeks	191.4±21.33	187.8±4.89	191.7±9.47	NS	187.3±6.82	188.8±7.58	194.9±16.75	NS
Egg No. bird / day								
(8-12) weeks	0.760±0.01^{c}	0.851±0.03^{a}	0.814±0.01^{b}	**	0.795±0.03^{c}	0.809±0.02^{b}	0.822±0.01^{a}	**
(12-16) weeks	0.788±0.01^{c}	0.866±0.01^{a}	0.835±0.04^{b}	**	0.856±0.01^{a}	0.827±0.01^{b}	0.806±0.02^{c}	**
(16-20) weeks	0.724±0.01^{c}	0.831±0.01^{a}	0.789±0.01^{b}	**	0.790±0.05^{b}	0809±0.01^{a}	0.745±0.04^{c}	**
(8-20) weeks	0.757±0.007^{c}	0.850±0.02^{a}	0.813±0.06^{b}	**	0.814±0.08^{a}	0.815±0.01^{a}	0.791±0.06^{b}	**
Egg weight (g) bird / day								
(8-12) weeks	11.6±0.04^{b}	11.8±0.04^{a}	11.8±0.04^{a}	**	11.7±0.04	11.7±0.40	11.8±0.04	NS
(12-16) weeks	11.9±0.04^{b}	12,2±0.04^{a}	12.2±0.05^{a}	**	12.0±0.05^{c}	12.1±0.06^{b}	12.3±0.08^{a}	**
(16-20) weeks	12.0±0.06^{b}	12.2±0.05^{a}	12.2±0.05^{a}	**	12.1±0.03^{b}	12.0±0.051^{b}	12.3±0.059^{a}	**
(8-20) weeks	11.8±0.03^{b}	12.0±0.02^{a}	12.1±0.02^{a}	**	11.9±0.02^{b}	11.9±0.027^{b}	12.1±0.30^{a}	**
Egg mass (g) / day								
(8-12) weeks	8.78±0.13^{c}	10.05±0.13^{a}	9.59±0.13^{b}	**	9.31±0.13	9.44±0.13	9.67±0.13	NS
(12-16) weeks	9.37±0.14^{b}	10.63±0.13^{a}	10.25±0.13^{a}	**	10.3±0.13	9.99±0.13	9.96±0.14	NS
(16-20) weeks	8.50±0.18^{c}	10.07±0.15^{a}	9.47±0.15^{b}	**	9.36±0.15^{ab}	9.61±0.15^{a}	9.07±0.17^{b}	*
(8-20) weeks	8.93±0.09^{c}	10.20±0.08^{a}	9.84±8.08^{b}	**	9.69±0.08	9.70±0.08	9.57±0.08	NS
Feed conversion								
(8-12) weeks	2.91±0.11	2.88±0.13	2.54±0.20	NS	3.02±0.11	2.65±0.11	2.67±0.11	NS
(12-16) weeks	3.61±0.13^{b}	2.86±0.13^{a}	3.10±0.13^{a}	**	3.05±0.12	3.19±0.13	3.33±0.13	NS
(16-20) weeks	4.49±0.20^{b}	3.19±0.19^{a}	3.57±0.20^{a}	**	3.76±0.19	3.53±0.20	3.96±0.20	NS
(8-20) weeks	3.90±0.16^{b}	3.07±0.16^{a}	3.08±0.16^{a}	**	3.37±0.16	3.38±0.16	3.29±0.16	NS
Mortality rate								
1-6 weeks	4.2±1.77	1.3±2.01	1.4±1.68	NS	1.4±1.01	2.7±1.36	2.8±1.90	NS
Economical efficiency								
1-6 weeks	3.978	4.557	4.378	-	4.368	4.415	4.130	-

Means in the same row within each classification bearing different letters are significantly ($P < 0.05$) different
** $P < 0.01$ and NS = not significant

Table 8. Productive performance (X±SE) of Japanese quail layers as affected by interaction between energy and protein levels during the experimental periods.

Energy level, K cal ME/kg	2800			2900			3000			Sign
Protein level (%)	18	20	22	18	20	22	18	20	22	
Body weight (g)										
8 weeks	197.5±7.14	199.5±2.63	199.9±4.16	197.4±10.93	196.6±6.105	196.7±9.58	198.3±5.44	190.95±5.90	196.2±6.65	NS
12 weeks	195.6±2.06	198.3±4.80	207.5±2.33	204.2±8.22	191.3±3.635	194.1±2.89	203.9±6.07	202.4±4.79	205.6±2.42	NS
16 weeks	210.3±4.63	198.0±9.30	223.2±4.73	213.2±7.38	212.4±4.162	216.8±3.97	216.8±5.80	216.8±3.51	223.2±3.18	NS
20 weeks	184.3±6.43	188.1±6.99	201.8±6.21	190.2±9.27	186.0±3.481	187.4±6.15	187.3±3.91	192.5±4.00	195.4±3.64	NS
Egg No./bird/day										
8 – 12 weeks	0.77±0.01ab	0.74±0.01ab	0.76±0.01a	0.85±0.08b	0.85±0.01b	0.85±0.01a	0.75±0.01a	0.83±0.01b	0.85±0.01a	**
12-16 weeks	0.81±0.02abc	0.81±0.09ab	0.73±0.02a	0.89±0.04ab	0.82±0.02ab	0.88±0.09ab	0.85±0.01b	0.84±0.08abcd	0.80±0.01ab	**
16–20 weeks	0.75±0.02abc	0.77±0.02ab	0.63±0.09a	0.82±0.02b	0.83±0.02ab	0.83±0.02b	0.78±0.02b	0.81±0.02b	0.76±0.02abc	**
8 –20 weeks	0.78±0.01abc	0.77±0.01ab	0.71±0.04a	0.85±0.01abc	0.83±0.01ab	0.85±0.01abcd	0.80±0.06b	0.83±0.09abc	0.80±0.03b	**
Egg weight (g)/ bird/day										
8 – 12 weeks	11.5±0.07ab	11.4±0.07ab	11.6±0.08a	11.7±0.07a	11.8±0.09ab	11.9±0.07abc	12.0±0.07b	11.7±0.07a	11.8±0.07abc	**
12–16 weeks	11.8±0.08b	11.8±0.08ab	11.9±0.09a	12.0±0.07abcd	12.1±0.06abcd	12.6±0.08abc	12.1±0.07a	12.2±0.07a	12.4±0.07abc	**
16–20 weeks	12.0±0.09abc	11.6±0.09ab	12.2±0.12a	11.9±0.09a	12.2±0.08ab	12.5±0.09b	12.2±0.08a	12.1±0.08abcd	12.2±0.09a	**
8 –20 weeks	11.8±0.04abc	11.7±0.04ab	11.9±0.05a	11.9±0.04abc	12.1±0.04abc	12.3±0.04b	12.1±0.04ab	12.0±0.04a	12.1±0.04ab	**
Egg mass (g)day										
8 – 12 weeks	8.9±0.23b	8.5±0.23b	11.6±0.08a	9.9±0.22b	10.0±0.23b	10.0±0.22ab	9.0±0.22a	9.7±0.22b	10.0±0.22a	**
12–16 weeks	9.6±0.23abc	9.6±0.24ab	11.9±0.09a	10.7±0.22b	9.9±0.23abc	11.1±0.24abc	10.4±0.23b	10.3±0.22b	9.9±0.23abc	**
16–20 weeks	8.8±0.28abc	8.9±0.27ab	12.2±0.12a	9.7±0.27ab	10.0±0.26ab	10.3±0.27abcd	9.4±0.26b	9.7±0.25b	9.1±0.26abc	**
8 –20 weeks	9.1±0.14abc	9.0±0.14ab	11.9±0.05a	10.1±0.14b	10.0±0.14b	10.5±0.14a	9.6±0.13abc	9.9±0.13b	9.7±0.14abcd	**
Feed conversion										
8 – 12 weeks	3.07±0.06	2.93±0.08	2.75±0.20	3.19±0.06	2.51±0.07	2.95±0.33	2.79±0.21	2.51±0.08	2.32±0.03	NS
12–16 weeks	3.42±0.31	3.36±0.16	4.04±0.12	2.75±0.20	3.17±0.10	2.65±0.13	2.98±0.17	3.02±0.09	3.28±0.23	NS
16-20 weeks	4.29±0.12	4.04±0.34	4.14±0.34	3.37±0.12	3.15±0.09	3.07±0.05	3.62±0.07	3.39±0.24	3.69±0.16	NS
8 –20 weeks	4.04±0.21	3.68±0.09	3.96±0.28	2.92±0.08	3.50±0.21	2.79±0.12	3.15±0.08	2.95±0.21	3.13±0.30	NS
Mortality rate										
1-6weeks	0.0±0.000	6.3±2.854	4.1±3.07	0.00±0.00	0.00±0.00	4.2±3.10	4.2±3.31	0.00±0.00	0.00±0.00	NS
Economical efficiency										
1-6weeks	4.078	4.109	3.748	4.641	4.478	4.552	4.386	4.658	4.090	-

Means in the same row within each classification bearing different letters are significantly (P< 0.05) different.

** P < 0.01 and NS = not significant

Table 9. Digestibility coefficients, and nutritive values of layer Japanese quails during winter season.

Dietary treatments		Digestibility coefficients %						Nutritive values (as fed)	
Energy level, Kcal ME./kg	Protein level (%)	DM	CP	EE	CF	NFE	OM	TDN (%)	Kcal ME /kg
2800		72.8±0.294^{a}	84.4±0.332	79.05±0.87^{a}	36.0±1.14	81.6±0.33^{b}	74.6±0.39a	71.30 ±0.43a	2994.5±18.18a
2900		72.3±0.307^{a}	84.0±0.410	77.2±0.66^{ab}	34.9±1.20	81.0±0.47^{b}	73.4±0.28^{ab}	68.80±0.51b	2889.7±16.08b
3000		71.3±0.190^{b}	83.5±0.295	74.7±0.49^{b}	35.7±0.99	82.9±0.29^{a}	72.7±0.09^{b}	65.29±0.38c	2742.5±10.81c
Significance		**	NS	**	NS	**	**	**	**
	18	73.2±0.40^{a}	84.1±0.19^{a}	75.8±0.48^{b}	37.3±1.21^{a}	82.5±0.35^{a}	75.4±0.51^{a}	66.05±0.47b	2774.3±15.91b
	20	71.3±0.35^{b}	82.7±0.42^{b}	74.9±0.73^{b}	37.7±1.08^{a}	81.6±0.45^{ab}	72.7±0.44^{b}	68.86±0.31a	2892.1±19.71a
	22	71.9±0.27^{b}	84.9±0.37^{a}	78.7±0.90^{a}	30.2±1.10^{b}	81.4±0.46^{b}	72.6±0.34^{b}	69.47±0.28a	2917.8±20.13a
Significance		**	**	**	**	*	**	**	**
2800	18	73.7±0.28	84.6±0.25a	79.4±1.29ab	36.2±0.99	81.5±0.37	76.3±0.25	66.14±0.4ab	2777.9±28.61ab
	20	71.2±0.37	81.4±0.71ab	77.9±1.31ab	37.6±1.72	80.6±0.60	72.6±0.48	64.46±0.6a	2707.3±26.52a
	22	73.3±0.50	84.3±0.57a	75.6±1.51a	34.2±1.98	81.7±0.58	74.9±0.68	65.29±0.7a	2742.2±31.49a
2900	18	73.7±0.21	84.6±0.67b	76.4±1.10bc	35.2±1.40	82.1±0.31	75.1±0.62	68.85±0.41b	2891.8±20.81b
	20	71.9±0.51	83.0±0.50ab	74.8±1.09abc	35.9±1.81	81.5±0.49	73.1±0.55	69.05±0.55bc	2900.1±25.70bc
	22	71.3±0.37	84.5±0.37b	78.5±1.41abc	33.8±0.85	80.4±0.35	72.1±0.47	68.46±0.81abc	2875.2±30.31abc
3000	18	72.2±0.51	82.3±0.55b	79.7±1.82b	36.8±1.96	83.1±0.47	75.0±0.68	71.42±0.88a	2999.6±24.81a
	20	70.8±0.22	83.2±0.48a	75.6±1.44b	37.4±1.25	82.8±0.55	72.2±0.50	71.41±0.72a	2994.2±27.59a
	22	70.9±0.19	85.1±0.54a	80.3±1.50a	35.6±1.33	83.0±0.66	71.1±0.37	71.29±0.29ac	2988.0±23.50ac
Significance		NS	*	**	NS	NS	NS	**	**

Means in the same column within each classification bearing different letters are significantly (P<0.05) different.

* P< 0.05 , ** P< 0.01 and NS = not significant

Table 10. Egg quality (X̄±SE) of Japanese quail layers as effected by energy level , protein level and their interaction during the whole experimental period.

Dietary treatments									
Energy level, Kcal ME /kg	Protein level (%)	Shape index	Albumen height (mm)	Yolk height (mm)	Yolk index	Shell thickness (mm)	Albumen %	Yolk %	Shell %
2800		0.78±0.010	4.95±0.116	11.7±0.115	0.48±0.023	0.23±0.003	54.9±0.455	30.6±0.301	14.5±0.295
2900		0.80±0.009	4.96±0.112	11.6±0.112	0.48±0.020	0.23±0.005	55.5±0.410	30.3±0.271	14.2±0.266
3000		0.79±0.012	4.99±0.105	11.6±0.107	0.47±0.018	0.22±0.004	54.7±0.317	30.9±0.277	14.4±0.244
Significance		NS	NS	NS	NS	NS	NS	NS	NS
	18	0.80±0.011	5.14±0.114	11.8±0.116	0.47±0.022	0.22±0.001	55.2±0.447	30.3±0.296	14.5±0.293
	20	0.79±0.009	4.95±0.103	11.6±0.107	0.48±0.020	0.23±0.002	54.7±0.402	30.6±0.266	14.6±0.260
	22	0.78±0.007	4.80±0.109	11.6±0.111	0.48±0.021	0.24±0.003	55.2±0.427	30.9±0.282	13.9±0.277
Significance		NS	NS	NS	NS	NS	NS	NS	NS
2800	18	0.81±0.014	5.16±0.227	11.9±0.227	0.48±0.044	0.22±0.001	55.3±0.890	30.5±0.588	14.2±0.576
	20	0.79±0.103	4.65±0.170	11.4±0.170	0.48±0.033	0.23±0.012	55.1±0.665	30.4±0.439	14.4±0.431
	22	0.76±0.017	5.03±0.203	11.8±0.202	0.49±0.040	0.25±0.003	54.4±0.795	30.8±0.525	14.7±0.515
2900	18	0.79±0.015	5.04±0.204	11.6±0.204	0.48±0.029	0.23±0.004	55.3±0.619	29.8±0.393	14.9±0.601
	20	0.80±0.104	5.11±0.166	11.7±0.166	0.49±0.030	0.23±0.008	55.3±0.703	30.3±0.418	14.4±0.394
	22	0.80±0.019	4.72±0.182	11.5±0.182	0.47±0.035	0.22±0.013	55.8±0.711	30.9±0.470	13.3±0.461
3000	18	0.78±0.012	5.22±0.184	11.8±0.184	0.47±0.042	0.22±0.003	54.9±0.618	30.6±0.428	14.4±0.467
	20	0.80±0.016	5.09±0.180	11.5±0.181	0.47±0.031	0.23±0.005	53.7±0.710	31.2±0.503	15.1±0.449
	22	0.79±0.011	4.65±0.178	11.5±0.178	0.47±0.017	0.22±0.020	55.4±0.680	30.9±0.454	13.6±0.552
Significance		NS	NS	NS	NS	NS	NS	NS	NS

NS = not significant

Interaction effects:

The interaction between energy and protein levels indicated that higher digestion coefficient of CP (84.6%) was obtained with birds fed on 18% CP level and 2800 or 2900 Kcal ME/kg energy level and that of EE (80.3%) was obtained in case of 22% CP level and 3000 Kcal ME/kg, while the high CF and NFE digestion coefficients were obtained in case of 20% CP level with the low energy level and 18% CP level with the high energy level, respectively.

Nutritive values:

It is observed that TDN and ME values were significantly influenced ($P<0.05$) by the three dietary energy and protein levels examined (Table 9). The TDN and ME values were decreased by increasing the dietary energy level (2800 to 3000 Kcal ME/kg) and the vice versa in case of the dietary protein level(18 to 22%).

Egg quality:

Data in Table 10 showed that egg quality characteristics studied (shape index, albumin height, yolk height, yolk index, shell thickness, albumin %, yolk %, and shell %) were not significantly influenced by the tested levels of protein, energy and their interactions. Similar results were obtained in Japanese quail by Murakami et al (1993) who found that egg shell percentage and egg shell thickness were not affected by dietary energy, protein levels or their interaction. Whereas, contradicting results were reported by Shrivastav et al (1994) who found that egg quality characteristics in quail (albumin index, shell percentage and shell thickness) were influenced by the tested levels of protein and energy.

In conclusion, a dietary level of 2900 Kcal ME/kg with 22% CP is recommended for the feeding of growing Japanese quail from 1 to 6 weeks of age while the dietary level of 2900 Kcal ME/kg with 18% CP is recommended for the feeding of layer Japanese quail from 8 to 20 weeks of age during winter season under Egyptian environmental conditions.

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احتياجات السمان اليابانى من الطاقة والبروتين تحت الظروف المصرية

١ – فصل الشتاء

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استخدم فى هذا البحث عدد ٤٨٦ كتكوت سمان يابانى غير مجنس عمر أسبوع ، ١٤٤ أنثى عمر ٨ اسابيع وذلك لتقدير الاحتياجات من البروتين و الطاقة للسمان اليابانى النامى و البياض خلال فصل الشتاء فى مصر (من يناير حتى مارس ٢٠٠١ ، درجة الحرارة تراوحت بين ١٧,٥ و٢٥,٨م°).

وقد صمم لذلك تجربتان عامليتان (٣×٣) كل منهما اشتملت على ٩ مجاميع تجريبية وتم تكوين العلائق التجريبية لتحتوى على ثلاث مستويات من الطاقة (٢٨٠٠، ٢٩٠٠، ٣٠٠٠ كيلو كالورى طاقة ممثلة/كجم عليقة) وثلاث مستويات من البروتين (٢٢، ٢٤، ٢٦%) خلال فترة النمو (١ – ٦ أسبوع) ، وكذلك احتوت العلاقة التجريبية التى استخدمت خلال فترة انتاج البيض (٨ – ٢٠ اسبوع) على ثلاث مستويات من الطاقة (٢٨٠٠، ٢٩٠٠، ٣٠٠٠ كيلو كالورى طاقة ممثلة/كجم عليقة) وثلاثة مستويات من البروتين (٢٢،٢٠،١٨ %).

ويمكن تلخيص نتائج هذا البحث فيما يلى :

التجربة الأولى : فترة النمو

- عند ٣ و ٦ أسابيع لوحظ زيادة في الوزن والغذاء المأكول لكتاكيت السمان التى أعطيت عليقة تحتوى على ٢٨٠٠، ٢٩٠٠ كيلو كالورى طاقة ممثلة /كجم عليقة مقارنة بالكتاكيت التى أعطيت عليقة تحتوى على ٣٠٠٠ كيلو كالورى طاقة ممثلة /كجم عليقة، بينما لم يكن لمستوى الطاقة تأثير معنوى على الزيادة اليومية الوزنية خلال كل الفترات التجريبية (١-٣ ، ٣-٦، ١-٦ أسابيع). وكذلك الغذاء المأكول ، الكفاءة التحويلية للغذاء ونسبة النفوق خلال الفترة التجريبية الكلية (١-٦ أسابيع)
- لم يكن لمستوى البروتين بالعليقة اى تأثير معنوى على كل صفات معدل أداء النمو ونسبة النفوق لكتاكيت السمان خلال كل الفترات التجريبية.
- صفات الذبيحة عند عمر ٦ أسابيع لم تتأثر معنويا بمستويات الطاقة والبروتين فى العلائق المستخدمة وكذلك التداخل بينهما.
- أفضل قيمة للكفاءة الاقتصادية تم تسجيلها لكتاكيت السمان التى غذيت على عليقة تحتوى على ٢٩٠٠ كيلو كالورى طاقة ممثلة /كجم عليقة مع ٢٢% بروتين خلال الفترة من ١حتى ٦ أسابيع).

التجربة الثانية : فترة إنتاج البيض

- أظهرت النتائج زيادة معنوية خلال الفترة من ٨ - ٢٠ اسبوع فى كل من عدد البيض وكتلة البيض للإناث التى غذيت على عليقة تحتوى على ٢٩٠٠ كيلو كالورى طاقة ممثلة /كجم عليقة مقارنة بالمستويات الأخرى ، بينما لوحظ تحسن معنوى لكل من وزن البيضة والكفاءة التحويلية للغذاء بتغذية الإناث على علائق تحتوى على مستويات ٢٩٠٠، ٣٠٠٠ كيلو كالورى طاقة ممثلة /كجم عليقة مقارنة بمستوى ٢٨٠٠ كيلو كالورى طاقة ممثلة /كجم عليقة.
- تم تسجيل زيادة معنوية فى عدد البيض ونقص معنوى فى وزن البيض للإناث التى تغذت على التوالى على مستويات ١٨، ٢٠ % بروتين خام مقارنة بـ ٢٢% بروتين خام.
- لم يتأثر عدد البيض وكتلة البيض ووزن البيض معنويا بالتداخل بين مستويات الطاقة والبروتين المستخدمة. كذلك لم تتأثر صفات جودة البيض التى تم دراستها معنويا بمستويات الطاقة والبروتين أو التداخل بينهما.
- سجلت الإناث التي تغذت على عليقة تحتوى على ٢٩٠٠ كيلو كالورى طاقة ممثلة /كجم عليقة مع ٢٠% بروتين افضل قيمة للكفاءة الإقتصادية خلال الفترة ٨ حتى ٢٠ أسبوع.
- مما سبق يمكن التوصية بتغذية السمان النامى (١ - ٦ اسابيع) على عليقة تحتوى على ٢٩٠٠ كيلو كالورى طاقة ممثلة / كجم عليقة مع ٢٢% بروتين ، وتغذية السمان البياض (٨ - ٢٠ اسبوع على عليقة تحتوى على ٢٩٠٠ كيلو كالورى طاقة ممثلة / كجم عليقة مع ١٨% بروتين وذلك خلال فصل الشتاء فى مصر.