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RESPONSE OF GROWING JAPANESE QUAIL RAISED UNDER TWO STOCKING DENSITIES TO DIETARY PROTEIN AND ENERGY LEVELS

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SUMMARY

The present study was performed to investigate the effect of dietary levels of protein and energy on growth performance and carcass traits of growing Japanese quail during 1-6 weeks of age under two stocking densities. A factorial design (2 x 2 x 3) arrangement was used included two stocking densities (12 birds or 24 birds in space of 40 x 50 cm), two levels of CP (22 and 24 %) and three levels of energy (2800, 2900 and 3000 kcal ME/ Kg).

The results of the present study showed that increasing stocking density of Japanese quails from 12 to 24 birds per 2000 cm² led to a significant (P≤0.01) reduction in live body weight at 3 and 6 weeks of age and body weight gain through 4-6 and 1-6 weeks of age. Live body weight at 3 weeks of age and live body weight gain during 1-3 of age were significantly (P≤0.01) maximized when chicks were fed 22% protein compared to those received 24% protein. Live body weight at 3 and 6 weeks of age and live body weight gain through 1-3 and 1-6 weeks of age were significantly (P≤0.01) decreased linearly with the increase in dietary energy from 2800 to 3000 kcal ME / kg diet. Interaction between stocking density and protein levels were significant (P≤0.05) on live body weight at 3 weeks of age and body weight gain through the whole experimental period (1-6 weeks of age). Quail kept at 80 cm² consumed (P≤0.01) less feed as compared with those kept at 160 cm² while, the best feed conversion ratio was obtained for birds kept at 160 cm² than birds kept at 80 cm². During 1-3 and 1-6 weeks of age, an improvement (P≤0.05) in feed conversion was noticed with lower protein level (22%). Increasing energy level in the quail grower diets from 2800 to 2900 and 3000 kcal/ME/ kg was associated with a significant (P≤0.05 or 0.01) decrease in feed consumption and significant (P≤0.01) improvement in feed conversion ratio during all the experimental periods studied. The present results did not show any significant effect on all studied carcass characteristics of growing Japanese quail due to stocking density, dietary protein and energy levels and their interaction, except giblets which was significantly (P≤0.05) higher in chicks fed diets contained 2900 and 3000 kcal ME/kg.

Keyword:

INTRODUCTION

The influence of stocking density of different poultry species on growth and reproductive performance has generated a dearth of information on Japanese quail (Abdel- Hakim *et al.*, 2005 and Abdel-Azeem, 2010). Intensive stocking density is one of the most effective stressors, especially during the final weeks of growing period (Askar and Assaf, 2004). Many investigators indicated that the high stocking density have been shown to induce poor conditions, reduction in growth rate, feed efficiency, livability and carcass quality (Puron *et al.*, 1995; Fahmy *et al*., 2005; Seker *et al*., 2009 and El-Sagheer *et al.*, 2012). Abdel-Azeem (2010) concluded that breeding of quail with a stocking density of 77 birds/m^2 might yields better results when compared with quails stocked at 100 birds/m^2 or those kept at 143 birds/m^2. However, there is a lack of information on the influence of stocking density on the performance of Japanese quail.

Protein source of high quality with adequate amino acid balance is one of the most important nutrients for quail. There are some differences in the nutritional requirements of quail as determined by various authors. Soares *et al.* (2003) evaluated five dietary crude protein levels (16, 18, 20, 22 and 24%) in the rearing period of Japanese quail and concluded that protein levels had no effects on feed consumption and feed conversion ratio. They added that a crude protein requirement for rearing period of Japanese quail is 23.08%.

The response of growing quails to dietary levels of essential amino acids, at different energy levels, on growth and immunity were investigated by Kaur *et al.* (2008). They concluded that the optimum level of dietary ME is 2700 kcal/kg with 25.83% CP for optimum feed conversion during 0-5 weeks of age. 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 and Mosaad and Iben, 2009).

Therefore, the present study was performed to investigate the effect of dietary levels of protein and energy on the performance of growing Japanese quail under two stocking densities.

MATERIALS AND METHODS

The present study was carried out at the quail Research Farm, Poultry Department, Faculty of Agriculture, Zagazig University. Zagazig, Egypt.

A factorial design arrangement (2 x 2 x 3) was performed included two stocking densities (12 birds or 24 birds in space of 40 x 50 cm), two levels of crude protein (22 and 24 %) and three levels of energy (2800, 2900 and 3000 kcal ME/ Kg) on growth performance and carcass traits of growing Japanese quail during 1-6 weeks of age. Therefore, a total number 648 of one week old Japanese quail were randomly assigned into 12 treatment groups, (36 chicks in each group of low stocking density and 72 chicks in each group of the high stocking density). Each group of birds was subdivided into three replicates, each of 12 chicks in the low stocking density and 24 chicks in the high stocking density. Each replicate was housed in one cage (40 x 50 cm) either for the low or high stocking densities, respectively. The experimental diets (6 diets) were formulated to have two levels of crude protein (22 and 24%) and three levels of energy (2800, 2900 and 3000 Kcal ME / Kg). Each experimental group in both low and high stocking density was fed one of the above mentioned diets (Table 1).

Quail chicks were grown in brooders with raised wire floors and were reared under the same managerial and hygienic conditions. The lighting pattern was 23 hr light: 1 hr dark. Feed and water were *ad-libitum* throughout the experimental period. Individual live body weight was recorded at 1, 3 and 6 weeks of age; also body weight gain was calculated. Feed consumption data were recorded during the periods 1-3, 4-6 and 1-6 weeks of age on a replicate basis to estimate feed conversion.

At the end of growing period (6 weeks of age), five birds from each treatment were randomly taken with an average body weight around the treatment mean, fasted overnight, weighed and slaughtered by sharp knife to complete bleeding, then weighed, followed by plucking the feather and finally weight. The slaughter traits studied were giblets (liver, gizzard and heart), and dressing % ((carcass weight plus giblets weight)*100 / pre-slaughter g).

Data were statistically analyzed on a factorial design (2 x 2 x 3) basis according to Snedecor and Cochran (1982) by adopting the following model:

$$X_{ijkl} = \mu + D_i + P_j + G_k + DP_{ij} + DG_{ik} + PG_{jk} + DPG_{ijk} + E_{ijkl},$$

where X_{ijkl} = any observation, μ = general mean, D_i = fixed effect of i^{th} stocking density (12 and 24), P_j = fixed effect of j^{th} level of crude protein (22 and 24 %), G_k = fixed effect of k^{th} level of energy (2800, 2900 and 3000 kcal ME/ Kg), DP_{ij} = interaction between stocking density and crude protein levels, DG_{ik} = interaction between stocking density and energy levels, PG_{jk} = interaction between crude protein levels and energy levels, DPG_{ijk} = interaction among stocking density, crude protein levels and energy levels and E_{ijkl} = random error.

Differences among treatment means within the same factor were tested using Duncan's New Multiple Range test (Duncan, 1955).

RESULTS AND DISCUSSIONS

Growth performance:

Live body weight and body weight gain:

Stocking density effect:

Results in Table 2 showed that, increasing stocking density of Japanese quails from 12 to 24 birds per 2000 cm² (83 cm^2 per bird) resulted in significant ($P \leq 0.01$) reduction in live body weight at 3 and 6 weeks of age and body weight gain during 4-6 and 1-6 weeks of age. This may be attributed to higher environmental temperature that occurred due to overcrowding. Overcrowding and less space per quail might cause stress on them. Also, in a high stocking density, the airflow at the level of the birds is often reduced resulting in reducing performance which include poor air quality due to inadequate air exchange, increased ammonia and reduced access to feed and water. Askar and Assaf (2004) attributed the unfavorable effects of high stocking density on live body weight and body weight gain of quail to the modification of the resting behavior due to the disturbances by the other birds.

Our results agreed with Fahmy *et al.* (2005) who observed that increasing stocking density of quail from 44, 88 and 176 birds/ m² was associated with significant decrease in body weight. Al-Hanafy (2012) indicated that high stocking density (125 cm²/bird) significantly ($P \leq 0.05$ or 0.01) decreased body weight at 7 weeks of age and body weight gain during 3-6 and 1-6 weeks of age. Seker *et al.* (2009) showed that body gain was higher for quail stocked at 3 quail per 125 cm^2 as compared with quail stocked at 10 quail per 125 cm^2.

On the contrary, stocking density in Japanese quail did not significantly affect either body weight (Abdel-Hakim *et al.,* 2005 and El-Sagheer *et al.*, 2012) or body weight gain (Dhaliwal *et al.,* 2008).

Protein level effect:

Results in Table 2 indicated a significant effect ($P \leq 0.01$) on body weight at 3 and 6 weeks of age and body weight gain during 1-3, 4-6 and 1-6 weeks of age due to protein level effect. It could be noticed that, live body weight at 3 weeks of age and live body weight gain during 1-3 of age were higher when chicks were fed 22 % protein compared to groups received 24 % protein. However, with progress in age (from 4 to 6 weeks of age), live body weight at 6 weeks of age and live body weight gain through 3-6 weeks of age and during the whole experimental period (1-6 weeks of age) were significantly ($P \leq 0.01$) higher in chicks that received 24 % crude protein. The positive effect of increasing protein level on growth performance may be due to increasing the amount of protein consumed.

Results of the current work are in agreement with those reported by Gheisari *et al.* (2011) who indicated that, increasing dietary protein in different stages of growth from very low, medium and high levels significantly ($P \leq 0.05$) increased body weight and body weight gain of growing Japanese quail. Also, Tarsewics *et al.* (2007) found that, quail fed diet containing very low protein level gave significantly lower body weight than those fed high protein diet.

Contradicting results were reported by Aboul-Ela *et al.* (2004) who showed that, the different protein levels (22, 24 and 26 %) had no significant influence on live body weight and body weight gain during the growing period of Japanese quail.

Energy level effect:

Data in Table 2 showed that, live body weight at 3 and 6 weeks of age and live body weight gain during 1-3 and 1-6 weeks of age were significantly ($P \leq 0.01$) decreased linearly with the increase in dietary energy from 2800 to 2900 and 3000 Kcal ME / kg diet.

These results agree with Aboul-Ela *et al.* (2004) who found that, Japanese quail chicks received 2800 and 2900 kcal ME/ kg diet up to 6 weeks of age were superior in live body weight than chicks received 3000 kcal ME/ kg by 4.31 and 2.55 %, respectively.

On the contrary, Gheisari *et al.* (2011) stated that, there were no significant effects of dietary ME levels (2700 or 2900 kcal ME/ kg) on body weight and body weight gain.

Interaction effects:

Interaction between stocking density and protein levels were significant ($P \leq 0.05$) on live body weight at 3 weeks of age and body weight gain through the whole experimental period (1-6 weeks of age). The interaction between stocking density and energy levels were significant ($P \leq 0.01$) on live body weight at 6 weeks of age and body weight gain through 1-6 weeks of age.

The interaction between protein and energy levels were significant ($P \leq 0.01$) on live body weight at 3 weeks of age and body weight gain during 1-3 and 1-6 weeks of age.

The interactions between stocking density, energy level and protein level were significant ($P \leq 0.01$) on live body weight at 3 weeks of age and body weight gain during 4-6 and 1-6 weeks of age.

Feed consumption and feed conversion:

Stocking density effect:

Results presented in Table 3 indicated that quail kept at 80 cm^2/bird consumed ($P \leq 0.01$) less feed as compared with those kept at 160 cm^2/bird. However, the best feed conversion ratio was obtained for birds kept at 160 cm^2 than birds kept at 80 cm^2. Feed consumption reduction may be due the reduction in floor space, which increases the competition for positions at the feeder trough. Al-Hanafy (2012) indicated that during all experimental periods (1-3, 4-6 and 1-6 weeks of age), high stocking density caused a significant improvement in feed conversion during 4-6 weeks of age.

However feed consumption was not significantly affected by stocking density during all the experimental periods. Seker *et al.* (2009) and Abdel-Azeem (2010) showed that the increasing in stocking density of Japanese quail resulted in a linear reduction in feed consumption. Al-Homidan and Robertoson (2007) indicated that increasing stocking density of Hybro broiler chicks from 10 to 15 birds / m^2 resulted in a reduction of feed consumption. However, they showed that feed conversion ratio was not significantly affected by increasing density from 10 to 15 bird / m^2.

Protein level effect:

Results shown in Table 3 showed that, dietary protein concentration did not affect average feed consumption through 1-3 and 4-6 weeks of age. However, from 1-6 weeks of age, significantly ($P \leq 0.01$) higher feed consumption was observed for the group fed high protein level. These results are in agreement with the finding of Gheisari *et al.* (2011) who found that, the highest daily feed consumption ($P \leq 0.05$) was observed in the group feed high level of protein during the second rearing period (15-28 days). Siyadati *et al.* (2011) found that the birds fed on diets containing high crude protein (27%) showed better feed conversion ratio than those fed other diets (24 or 21%).

During 1-3 and 1-6 weeks of age, a significant (P≤0.05) improvement in feed conversion was observed with lower protein level (22%). However, protein level had no significant effect on feed conversion ratio during 4-6 weeks of age (Table 3).

The results of the present work are in agreement with those of Abou-Zeid *et al.* (2000), Abdel-Azeem *et al.* (2001) and Aboul-Ela *et al.,* (2004) who reported that feeding growing Japanese quail a diet contained 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). Barque *et al.* (1994) found that the minimum feed consumption and better feed efficiency was noted in birds fed 26% protein diet.

Energy level effect:

Results in Table 3 showed that, increasing energy level in the quail grower diets from 2800 to 3000 kcal/ME/ kg was associated with a marked significant (P≤0.05 or 0.01) increase in feed consumption and significant (P≤0.01) improvement in feed conversion ratio during all the studied experimental periods. This means that during the starter and finisher periods, the lower energy feed was responsible for any increase in feed consumption. 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.

These results are in good agreement with those reported by Gheisari *et al.* (2011) who reported that feed consumption of Japanese quail increased linearly with decreasing dietary energy level from 2900 to 2700 kcal/ ME /kg. Kaur *et al.* (2008) reported that feed consumption of Japanese quail increased and feed conversion improved with decreasing dietary energy from 3100 to 2900 and 2700 kcal ME/kg during 0-3 or 0-5 weeks of age.

Interaction effects:

Results obtained in this study revealed that feed consumption was not significantly affected by the interaction between density × protein, density × energy and density × protein × energy during all the studied experimental periods (Table 3). However, feed consumption was significantly influenced (P≤0.01) by the interaction between protein × energy levels only at the periods from 1-3 and 4-6 weeks of age. These results agreed with Aboul-Ela *et al.* (2004) who revealed that feed consumption was not significantly affected by the interaction between protein × energy levels through all the studied experimental periods. Askar and Assaf (2004) clarified that the interaction effect between stocking density with protein level did not show and significance difference in feed consumption values of growing quail, while its effect was significant (P≤0.05) for feed conversion through 1-4 and 4-7 weeks of age.

Feed conversion values were significantly affected (P≤0.05 or 0.01) due to the interaction between density × energy during 4-6 and 1-6 weeks of age, density × energy during 1-6 weeks of age, protein × energy during all the experimental periods and between density × protein × energy at the period from 3-6 and 1-6 weeks of age.

Aboul-Ela *et al.* (2004) found that feed consumption and feed conversion were not significantly affected by the interaction between protein and energy levels.

Mortality rate (%):

Stocking density effect:

Results presented in Table 3 illustrated that mortality rate (%) recorded during all the experimental period of growing Japanese quail was significantly (P≤0.01) increased in those reared in the high stocking density as compared with the lower one. Mortality rate (%) in this study indicated that overcrowding and space per quail might cause stress in quail and this led to increasing mortality rate.

These results are in agreement with those of Abdel-Hakim *et al.* (2005), Dhaliwal *et al.* (2008) and Abdel-Azeem (2010) who indicated that increasing stocking density of Japanese quail significantly increased mortality rate. On the other hand, Al-Hanafy (2012) indicated that mortality rate of growing Japanese quail was not significantly affected by stoking density.

Protein level effect:

Mortality rate (%) of growing Japanese quail was not significantly affected by dietary protein level (Table 3). Similar results were obtained by Özek (2006) and Abdel-Mageed (2012). Tarasewicz *et al.* (2006) found that mortality rate was at similar level in Japanese quail fed diets contained 21, 19 and 17% crude protein.

Energy level effect:

Results in Table 3 showed that, increasing energy level in the quail grower diets from 2800 to 3000 kcal/ME/kg was associated with a significant (P≤0.05 or 0.01) decrease in mortality rate (%).

Abdel-Hakim *et al.* (2009) stated that mortality percentage during the whole experimental period ranged between 5 to 7.50 %. Almost all mortalities recorded in the present study were due to accidental factors during handing of birds and not to treatments.

Interaction effects:

Results shown in Table 3 indicated that mortality rate (%) was significantly influenced ($P \leq 0.01$) by the interaction between the studied factors at all experimental period. Hassanein (2004) claimed that mortality rate during the period of 1 – 6 weeks of age in quail was not significantly affected by either energy level, protein level or their interactions in winter or summer seasons.

Carcass characteristics:

Results in Table 4 did not show any significant effect on all studied carcass characteristics of growing Japanese quail due to stocking density, different dietary protein and energy levels or their interactions, except giblets which was significantly ($P \leq 0.05$) affected by energy levels. Giblets percentage was higher in chicks fed diets contained 2900 and 3000 kcal ME/kg than those fed 2800 kcal ME/kg.

Results of the present work are in agreement with those of Mizubuti *et al.* (2000) and Seker *et al.* (2009) who revealed that stocking density had no significant effect on slaughter and carcass characteristics. Aboul-Ela *et al.* (2004) found that carcass traits (carcass, giblets and dressing percentages) were not affected due to either the different dietary energy and protein levels or their interactions. Mosaad and Iben (2009) concluded that the dressing percentage was significantly ($P \leq 0.01$) different due to the interaction of energy and protein levels. There was a linear increase of dressing % with the increase in crude protein and energy levels being highest in high protein and high energy diet. Siyadati *et al.* (2011) reported that quail fed diets containing low crude protein (21%) gave lowest carcass yield than those fed higher protein diets (24 and 27%).

In conclusion, the results of this study indicated that, low stocking density (160 cm^2) was sufficient to give the best performance of Japanese quail. Taking body weight gain into consideration, the level of 22 % CP may be recommended till 3 weeks of age and 24 % may be recommended from 4-6 weeks of age. Moreover, a level of 2800 kcal ME/ kg diet would be suitable from 1-6 weeks of age.

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Table 1. Composition and calculated analysis of the basal diets

Ingredients	22% Crude protein			24% Crude protein		
	2800 Kcal/kg	2900 Kcal/kg	3000 Kcal/kg	2800 Kcal/kg	2900 Kcal/kg	3000 Kcal/kg
Yellow corn	57.57	61.00	63.02	54.13	57.27	58.69
Soybean meal (44%)	28.00	29.50	23.10	30.10	30.10	24.60
Corn gluten meal (60%)	4.00	5.00	7.00	5.50	6.00	10.00
Wheat bran	5.00	0.00	0.00	4.00	0.00	0.00
Cotton seed oil	0.00	0.00	0.35	0.00	0.40	0.40
Fish meal 72%	2.00	1.00	3.00	3.00	3.00	3.00
Limestone	1.00	1.00	1.00	1.00	1.00	1.00
Vit. & Min. premix (1)	0.30	0.30	0.30	0.30	0.30	0.30
NaCl	0.30	0.30	0.30	0.30	0.30	0.30
Di-calcium Phosphate	1.50	1.50	1.50	1.50	1.50	1.50
Dl- Methionine	0.20	0.22	0.17	0.13	0.10	0.05
L-Lysine HCl	0.13	0.18	0.26	0.04	0.03	0.16
Total	100	100	100	100	100	100
Calculated analysis (2)						
C.P %	22.13	22.05	22.08	24.15	24.04	23.95
ME kcal/kg	2809	2911	3004	2805	2913	3007
Ca %	0.80	0.80	0.80	0.81	0.81	0.81
Avail. P %	0.46	0.46	0.46	0.47	0.47	0.47
Lysine %	1.31	1.33	1.35	1.31	1.31	1.30
Methionine %	0.42	0.43	0.43	0.43	0.43	0.42
Met.+ Cys. %	0.75	0.76	0.76	0.76	0.76	0.75

(1) Growth vitamin and Mineral premix, each 2.5 kg consists of: Vit A 12000, 000 IU; Vit D_3, 2000, 000 IU; Vit. E. 10g; Vit k_3 2 g; Vit B_1, 1000 mg ; Vit B_2, 49g ; Vit B_6, 105 g; Vit B_{12}, 10 mg; Pantothenic acid, 10 g; Niacin, 20 g , Folic acid , 1000 mg ; Biotin, 50 g; Choline Chloride, 500 mg, Fe, 30 g; Mn, 40 g; Cu, 3 g; Co, 200 mg; Si, 100 mg and Zn, 45 g.

(2) Calculated according to NRC (1994).

Table 2. Live body weight and body weight gain of quail as affected by density, protein and energy levels and their interactions

Treatments	Live body weight (g) at			Body weight gain (g)		
	1st week of age	3rd week of age	6th week of age	1 – 3 weeks	4 – 6 weeks	1 – 6 weeks
	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.
Density levels:	NS	**	**	NS	**	**
12	30.46±0.25	79.93^a±0.80	183.71^a±1.36	49.47±0.93	103.78^a±1.63	153.24^a±1.46
24	30.18±0.20	76.06^b±1.08	162.68^b±1.19	45.88±1.15	86.62^b±1.32	132.50^b±1.24
Protein levels %:	NS	**	**	**	**	**
22	30.41±0.26	79.51^a±1.08	170.49^b±2.52	49.10^a±1.20	90.98^b±2.11	140.08^b±2.50
24	30.24±0.19	76.49^b±0.09	175.90^a±3.01	46.25^b±0.94	99.42^a±2.55	145.66^a±3.03
Energy levels Kcal/kg:	NS	**	**	**	NS	**
2800	29.92±0.12	80.90^a±1.07	175.76^a±3.86	50.98^a±1.10	94.85±3.67	145.84^a±3.90
2900	30.57±0.40	77.93^b±1.31	173.24^b±2.58	47.36^b±1.44	95.31±2.66	142.66^b±2.47
3000	30.47±0.22	75.16^c±0.91	170.58^c±3.88	44.68^c±0.91	95.43±3.12	140.11^c±3.88
Interaction effects:						
Density × Protein	NS	*	NS	NS	NS	**
Density × Energy	NS	NS	**	NS	NS	**
Protein × Energy	NS	**	NS	**	NS	*
Density × Protein × Energy	NS	**	NS	NS	**	**

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

Means bearing different letters in the same column, within each factor, differ significantly (P≤0.05).

Table 3. Feed consumption and feed conversion of quail as affected by density, protein and energy levels and their interactions

Treatments	Feed consumption (g) at			Feed conversion (g gain/g feed)			Mortality rate (%) during 1-6 weeks
	1 – 3 weeks	4 – 6 weeks	1 – 6 weeks	1 – 3 weeks	4 – 6 weeks	1 – 6 weeks	
	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.	$\overline{X}$ ± S.E.
Density levels:	**	**	**	**	**	**	**
12	187.37^{a}±3.39	375.34^{a}±5.78	643.02^{a}±6.06	3.82^{a}±0.09	3.62^{a}±0.06	3.78^{a}±0.05	1.39^{b}±0.61
24	132.25^{b}±3.66	299.65^{b}±7.22	511.90^{b}±8.49	2.92^{b}±0.11	3.46^{b}±0.07	3.43^{b}±0.08	4.51^{a}±1.49
Protein levels:	**NS**	**NS**	**	**	**NS**	**	**NS**
22	157.27±7.58	322.11±11.10	559.38^{b}±17.25	3.22^{b}±0.15	3.53±0.06	3.55^{b}±0.08	2.78±0.81
24	162.67±7.55	352.88±10.14	595.54^{a}±16.71	3.51^{a}±0.14	3.56±0.07	3.65^{a}±0.06	3.12±1.49
Energy levels:	*	*	**	**	**	**	**
2800	152.75^{b}±10.55	318.95^{c}±12.87	551.70^{c}±22.88	3.00^{b}±0.21	3.37^{b}±0.09	3.37^{c}±0.08	5.21^{a}±2.13
2900	165.25^{a}±9.95	332.22^{b}±13.44	577.46^{b}±20.14	3.48^{a}±0.18	3.47^{b}±0.06	3.60^{b}±0.07	3.64^{b}±0.93
3000	161.90^{ab}±7.08	361.32^{a}±12.58	603.23^{a}±19.43	3.61^{a}±0.09	3.79^{a}±0.03	3.83^{a}±0.04	0.00^{c}±0.00
Interaction effects:							
Density × Protein	**NS**	**NS**	**NS**	**NS**	*	*	**
Density × Energy	**NS**	**NS**	**NS**	**NS**	**NS**	*	**
Protein × Energy	**	**	**NS**	**	*	*	**
Density × Protein × Energy	**NS**	**NS**	**NS**	**NS**	*	**NS**	**

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

Means bearing different letters in the same column, within each factor, differ significantly (P≤0.05).

Table 4. Carcass traits of quail as affected by density, protein and energy levels and their interactions

Treatments	Pre-slaughter weight %	Carcass %	Giblets %	Dressing %
Density levels bird/cm:	**NS**	**NS**	**NS**	**NS**
12	146.44	70.35	5.55	75.90
24	143.78	70.08	5.84	75.92
Protein levels % :	**NS**	**NS**	**NS**	**NS**
22	141.33	69.39	5.73	75.12
24	148.89	71.04	5.66	76.70
Energy levels Kcal/kg:	**NS**	**NS**	*	**NS**
2800	147.17	69.88	5.08^{b}	74.97
2900	144.92	70.71	5.97^{a}	76.68
3000	143.25	70.06	6.03^{a}	76.09
Density × Protein	**NS**	**NS**	**NS**	**NS**
Density × Energy	**NS**	**NS**	**NS**	**NS**
Protein × Energy	**NS**	**NS**	**NS**	**NS**
Density × Protein × Energy	**NS**	**NS**	**NS**	**NS**

NS = Not significant and * = P<0.05

Means bearing different letters in the same column, within each factor, differ significantly (P≤0.05).

إستجابة السمان الياباني النامي المربى تحت كثافتين للقطيع لمستويات البروتين و الطاقة في العليقة

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أجريت هذه الدراسة لدراسة تأثير مستويات العليقة من الطاقة والبروتين على أداء السمان الياباني النامي وصفات الذبيحة تحت كثافتين للقطيع في الفترة من ١ إلى ٦ أسابيع. تم عمل تجربة ذات تصميم عاملي (٢ × ٢ × ٣)، اشتمل علي كثافتين للقطيع (١٢ و ٢٤ طائر في مساحة ٤٠ × ٥٠ سم و مستويين للبروتين (٢٢ و ٢٤% بروتين خام) وثلاث مستويات من الطاقة (٢٨٠٠ و٢٩٠٠ و٣٠٠٠ كيلو كالورى طاقة ممثلة / كجم علف).

توضح النتائج في هذه الدراسة أن زيادة كثافة القطيع من ١٢ إلى ٢٤ طائر في مساحة ٢٠٠٠سم^{٢} أدت إلى انخفاض معنوي عند (٠.٠١) في وزن الجسم الحي عند ٣ و٦ أسابيع من العمر وكذلك مقدار الزيادة في وزن الجسم خلال ٤-٦ و خلال ١-٦ أسابيع من العمر. بلغ وزن الجسم الحي عند ٣ أسابيع من العمر والزيادة في وزن الجسم خلال ١-٣ أسابيع أقصى قيمة لها عندما تغذت الكتاكيت على عليقه بها ٢٢% بروتين عند مقارنتها بتلك التي تغذت على عليقه بها ٢٤ % بروتين. انخفض وزن الجسم الحي عند ٣، ٦ أسابيع من العمر ومقدار الزيادة في وزن الجسم خلال الفترة من ٤-٦، ١-٦ أسابيع من العمر انخفضت معنويا عند مستوى (٠.٠١) عند زيادة مستوى الطاقة في العليقة من ٢٨٠٠ إلى ٣٠٠٠ كيلو كالورى طاقة ممثلة /كجم علف. اثر التداخل بين الكثافة ومستويات البروتين معنويا عند مستوى (٠.٠٥) على وزن الجسم الحي عند عمر ٣ أسابيع وكذلك على مقدار الزيادة في وزن الجسم طول مدة التجربة (١-٦ أسابيع من العمر). قل استهلاك العلف معنوياً عند مستوى (٠.٠١) في السمان المربى في مساحة ٨٠ سم^{٢} عند مقارنته بالسمان المربي في مساحة ١٦٠ سم^{٢} بينما أفضل نسبة تحول للغذاء تم الحصول عليها في الطيور المرباة في مساحة ١٦٠ سم^{٢} عن الطيور المرباة في مساحة ٨٠ سم^{٢}. تحسنت قيم التحول الغذائي معنويا (٠.٠٥) خلال الفترات ١-٣ , ١-٦ أسابيع من العمر عند استخدام مستوى ٢٢% بروتين. وبزيادة مستوى الطاقة في العليقة للسمان النامي من ٢٨٠٠ إلى ٢٩٠٠ و ٣٠٠٠ كيلو كالورى طاقة ممثلة / كجم علف حدث انخفاض معنوي عند مستوى (٠.٠٥ , ٠.٠١) في استهلاك الغذاء بينما تحسن معنويا عند (٠.٠١) نسبة التحول الغذائي طول فترة التجربة التي درست. لم يتضح أن كثافة القطيع ومستويات البروتين والطاقة والتدخل بينهما، لها أي تأثير معنوي على صفات الذبيحة التي تم دراستها على السمان النامي، فيما عدا الأحشاء التي كانت أعلى معنويا عند (٠.٠٥) في الكتاكيت التي تغذت على عليقه تحتوى على ٢٩٠٠ و ٣٠٠٠ كيلو كالورى طاقة ممثلة / كجم علف.