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Growth Performance, Blood Biochemical Changes, Carcass Traits and Nutrient Digestibility of Growing Japanese Quail Fed on Various Dietary Protein and Calcium Levels

Mohamed. I. El-Katcha, Mosaad. A. Soltan, Ramdan, S. Sheaita, El Naggar, M. Karima and Set A. El-Shobokshy
Department of Animal Nutrition and Clinical Nutrition, Faculty of Vet. Medicine, Alexandria University.

Key words

Protein levels, Calcium levels, Growing quail, Growth performance, Nutrient digestibility.

ABSTRACT:

Seven hundred and twenty of 14 day old Japanese quail chicks were used in this study to evaluate the effect of various dietary protein and calcium levels on growth performance, carcass traits, blood biochemical changes and nutrient digestibility of growing Japanese quail. The chicks were individually weighed, randomly allocated into 6 groups of mixed sex (120 quails per each group). Quail chicks of groups 1, 2 and 3 were fed on the experimental diet containing 24% crude protein with standards calcium content according to NRC recommendation (0.8%) or 25% more calcium than NRC 1994, recommendation (1.0%) and 50% higher calcium than the requirement (1.2%%) for the three groups respectively, while chicks groups 4, 5 and 6 fed on the experimental diet containing 21% crude protein with 0.8 or 1.0 and 1.2% calcium respectively. The obtained data revealed that high protein diet reduced final body weight and total gain when compared with lower protein fed group. While 25% or 50% high calcium more than recommended requirement improved final body weight and total gain when compared with chicks group fed on the same protein level with standard calcium content. The best FCR and PER values were obtained by quail chicks group fed on lower protein level with 25% high calcium content. All treatment had no significant effect on blood picture, blood serum total protein, albumin, globulin, glucose, triglycerides and cholesterol concentrations. Regarding blood serum calcium and phosphorus concentrations, it was observed that higher protein diet with standard calcium level increased ($P \geq 0.05$) both calcium and phosphorus blood serum concentration by about 6.8% and 65.1% respectively, when compared with quail chicks group fed on low protein diet with standard calcium level. Moreover, 25% more calcium improves immune response parameters but all treatments had no effect on carcass traits. The obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets decreased Dry matter, Organic matter, Inorganic matter (ash), Crude protein, Ether extract, Crude fiber and nitrogen free extract digestibility by about 6.8%, 3.8%, 39.7, 0.17%, 1.8%, 7.9% and 3.7% when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. It can be concluded that 21% crude protein with 1.0% calcium level improve growth performance, feed efficiency and some blood parameters of growing Japanese quail.

Corresponding Author: Set A. El-shobokshy seet1989@yahoo.com

1. INTRODUCTION

The shortage of animal protein intake among the ever increasing human population in the third world countries has long been recognized and remains one of the greatest issues of concern today (Omikhoje et al., 2008). Developing Countries including Egypt are deficient in animal protein security with the per capita consumption put at lower than 10.0 g/per day as against the minimum daily intake of 35 g recommended by Food and Agricultural Organization to be the minimum requirement for the growth and development of the body (Esobhawan et al., 2008). One way of increasing protein supply is to improve poultry production as well as increase the production of other small livestock species with short generation intervals. Among these is the Japanese quail **(Coturnix coturnix Japanica).** Generally quail occupy a small but special segment of the Egyptian poultry industry.

These birds are raised as source of specialty egg and meat. Japanese quail have the advantage of rapid growth rate, small size, good reproductive potential, short life cycle, low feed requirements, good meat taste, better laying ability and shorter time of hatching as compared with the different species of poultry (Roshdy et al., 2010 and Siyadati et al., 2011). So that these birds are expected to increasing play a role in food security, necessitating means to improve their

productivity. One of the areas that need particular attention is nutrition of the birds. The optimum performance of livestock depends largely on the quality and quantity of their dietary nutrients. Compared to other game birds, requirements of Japanese quail are more documented (NRC, 1994), but are to fare to be compared with other domestic fowl and they are missing last 20 years. Nutrient requirements of Japanese quail ore often extrapolations of results from the other poultry (Minivielle, 2004), but they are not the same with chickens in terms of poultry production and what is true for chickens is not always true for quail (Cheng and Kimura, 1990)**.** The most comprehensive review on the nutrition of Japanese quail is prepared by (Shim and Vohra, 1984). They have concluded that requirements of quail protein, calcium and phosphorus seem to be higher than for other fowl at comparable ages.

However, currently, there is no commercial feed for quails in the Egyptian livestock feed industry as against chickens so, most quail farmers, have to use commercial Broiler's feeds containing {21 -23% crude protein (CP) and 1.0% calcium (Ca)} to feed quail chicks, other farmers produce their own feed based on recommended nutrient requirement of Japanese quail (NRC, 1994). On the other hand, most of the data on nutritional requirements for Japanese quail were obtained in other countries that have different climatic conditions, preventing that an adequate feeding program is established. It is important to determine more precisely the nutritional requirement of quails raised in Egypt. Although data not produced in our country can be used in feed formulation for quails, this might result in lower productivity and poor economic performance due to the use of a possible excess or less of some nutrients in the diet. Protein of high quality with adequate amino acid balance is one of the most important nutrients for quails. It is also one of the most expensive nutrients.

Four crude protein levels (20, 22, 24 and 26%) were evaluated for Japanese quails and it was concluded that after lysine and methionine + cystine requirements were met, 20% crude protein level resulted in best performance from 1 to 42 days of age (Murakami et al., 1993). Hyankova et al. (1997) reported that Japanese quails fed 26 and 21.6% crude protein had good performance from 1 to 21 and from 22 to 35 days of age, respectively. Thus, requirements decrease with age, similar to other animal species.

So that the main objective of this research was to estimate the effect of different dietary crude protein and calcium levels of growing Japanese quails on growth performance, some blood biochemical parameters, immune response, carcass traits and nutrient digestibility.

2. MATERIALS AND METHODS

Birds used: Seven hundred and twenty of 14 day old Japanese quail chicks had average body weight about 68.6gm were used. They were obtained from Faculty of agriculture, Alexandria University. The chicks were individually weighed, randomly allocated into 6 groups of mixed sex (120 quails per each group).

Accommodation and management: The chicks were housed in a clean well ventilated room previously fumigated with formalin and potassium permanganate. The room as provided with electric heaters to adjust the environmental temperature according to age of the birds. The room floor was partitioned into 6 equal compartments (1.75 x 1.5 m^2), each compartment was bedded by fresh clean chopped wheat straw forming a deep litter of 4 Cm depth. Each compartment was covered by wire mesh for separation of chick groups. Each compartment was provided by suitable feeder and waterer. Feeds and water were supplied ad-libitum. Prophylactic measures against the most common infectious diseases were carried out by using chromphenicol (1 ml/2 liter of drinking water), colistine sulphate (1 g/4 liter of drinking water) for salmonella and E.coli, and Doxycycline 20% (1 g/liter of drinking water) and cephadrine HCl (0.5 g/Liter of drinking water) for clostridria infection while, Bay-cox was used for controlling coccidosis. The growing period of chicks lasted for 4 continous weeks (14 – 42 day).

Experimental design and feeding program: Experimental diets were corn – soybean based and contain 24% (standard protein requirement according to NRC 1994, recommendation) or 21% crude protein and nearly similar in other nutrients and metabolizable energy. Each protein level formulated with different three calcium content (0.8, 1.0 and 1.2%) to formulate six different experimental diets. The ingredient composition and chemical analysis of the experimental diets used in the growing period are presented in table 1. The applied experimental design during the growing period is illustrated in table (2), in which quail chicks of groups 1, 2 and 3 were fed on the experimental diet containing 24% crude protein with standards calcium content according to NRC

recommendation (0.8%) or 25% more calcium than NRC 1994, recommendation (1.0%) and 50% higher calcium than the requirement (1.2%) for the three groups respectively, while chicks groups 4, 5 and 6 fed on the experimental diet containing 21% crude protein with 0.8 or 1.0 and 1.2% calcium respectively.

Measurements: Body weight development, body weight gain and feed intake of quail birds in different groups were weekly recorded. Feed Conversion Ratio (FCR) and Protein Efficiency Ratio (PER) were calculated according to Lambert *et al*. (1936); McDonald *et al*. (1987) and North (1981) respectively.

Evaluation of immune response: Immune response of birds was estimated by a group of parameters including Phagocytic activity, phagocytic index and differential leukocytic count

Phagocytic activity and phagocytic index: These parameters were determined according to Kawahara *et al*. (1991)**.** Fifty micrograms of Candida albicans culture was added to 1 ml of citrated blood collected at the end of experiment. Treated blood samples were put in shaker water bath at 23 – 25º C for 3 – 5 hrs. Smears of blood were made and then stained with Geimsa stain. Phagocytosis was estimated by determining the proportion of macrophages which contain intracellular yeast cells in a random sample of 300 macrophages and expressed as percentage of phagocytic activity (PA). The number of phagocytized candida cells was counted in the phagocytic cells to calculate the phagocytic index according to the following equations:

Phagocytic activity (PA) = Macrophages containing yeast/Total number of Macrophages X100.
Phagocytic index (PI) = Number of cells phagocytized/Number of phagocytic cells.

- **Differential leukocytic count:** This test was done at the end of experiment. Blood film was prepared according to the method described by Lucky (1977). Ten drops from May-Grunwald stain stock solution were added to equal amount of distilled water on a dry unfixed smear then mixed and left for 1 minute for staining. The dye was decanted without rinsing. Diluted Geimsa stain was poured over the film as counter stain and left for 20 minutes then rinsed in water current and examined by oil emersion lens. The percentage and absolute value for each type of cells were calculated according to Schalm (1986).

Blood samples: At the end of the experimental period, blood samples were taken from 4 birds from each group. The blood samples were left to drop on the side of the tube to prevent destruction of RBCs. Each blood sample was left to coagulate at room temperature. Separation of serum was carried out by centrifugation of coagulated blood at 3000 rpm for 10 min. The clear serum was transferred carefully to clean and dry vials and kept in deep freezer until analysis for determination of serum glucose, total serum protein, albumin, globulin, calcium, phosphorus, triglycerides, total cholesterol, LDL, HDL, uric acid, creatinine, GOT and GPT using kits from Biodiagnostic Co.

Digestibility determination: Digestibility determined by accurately measuring feed intake and fecal output. During last week of growing period of quail chicks, the excreta were quantitatively collected for 5days successive days during which feed consumption data were also recorded. The excreta were weighted then dried in hot air oven, following this, excreta was allowed to equilibrate in moisture with the air before being weighed, then finally ground and stored until chemical analysis for determination of different nutrients.

Carcass characteristic: At the end of the experimental period, 5 chicks from each groups were randomly selected and scarified to calculate the dressing percentages, also collect the liver, heart, gizzard, spleen, bursa, thymus gland and relative weight of each organ was calculated as follows: Relative weight = (organ weight/Live body weight) X 100.

Analytical methods: Analytical DM contents of diets and fecal samples were determined by oven-drying at 105ºC for 48h (AOAC, 1985). Ash contents of diets and fecal samples were determined by incineration at 550ºC overnight. Crude protein of diets was determined by using Kjeldahl method according to Randhir and Pradhan (1981) while fecal nitrogen was determined following the procedures outlined by Jakobsen et al. (1960), and ether extract was determined according to Bligh and Dyer (1959) technique as modified by Hanson and Olly (1963). **Moreover,** calcium and phosphorus content in diet and fecal samples were determined according to according to Slavin (1968) and Geriche and Kurmies (1952) respectively.

Statistical analysis: The analysis of variance for the obtained data was performed using Statistical Analysis System (SAS, 1996) to assess significant differences among the different examined groups.

Table (1): Physical and Chemical composition of the experimental diets used during growing period.

Items	Experimental diets No.					
	1	2	3	4	5	6
Physical ingredients:						
Yellow corn, ground	52.17%	51.38%	50.39%	59.83%	59.24%	58.8%
Soybean meal (44%CP)	36.7%	36.7%	36.9%	31%	31%	31%
Corn gluten meal (60%CP)	7.0%	7.0%	7.0%	5.0%	5.0%	5.0%
Vetagable oils	0.8%	1.0%	1.2%	0.6%	0.6%	0.6%
Ground limestone[1]	1.35%	1.94%	2.53%	1.37%	1.96%	2.54%
Monocalcium phosphate[2]	1.14%	1.14%	1.14%	1.2%	1.2%	1.2%
Common salt	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Vitamin and mineral mix[3]	0.3%	0.3%	0.3%	0.3%	0.3%	0.3%
Lysine [4]	0.03%	0.03%	0.03%	0.14%	0.14%	0.14%
Methionine[5]	0.06%	0.06%	0.06%	0.11%	0.11%	0.11%
Choline [6]	0.05%	0.05%	0.05%	0.05%	0.05%	0.05%
Mycotoxin adsorbant[7]	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Chemical composition:						
Moisture%	13.2	13.7	13.4	13.9	13.2	12.9
Crude protein%	23.7	23.7	24.5	20.9	20.9	20.4
Ether extract%	4.3	4.6	4.39	4.79	4.49	4.23
Ash%	5.66	6.6	6.43	6.06	5.86	7.82
Crude fiber%	3.96	3.95	3.95	3.67	3.66	3.65
NFE%[8]	49.18	47.45	47.33	50.68	51.89	51.54
Calcium%	0.87	1.12	1.32	0.89	1.09	1.28
Phosphorus%	0.49	0.53	0.55	0.45	0.65	0.46
Methionine%[9]	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Lysine%[9]	1.29%	1.29%	1.3%	1.24%	1.24%	1.24%
ME Kcal/Kg[9]	3012.04	3001	3001	3044.27	3024.03	3008.94

1- Lime stone contains 37% calcium & locally produced. 2- Mono calcium phosphate: contain 21% phosphor and 17% calcium. 3- each 2.5kg contains: Vit A (12000000Iu), vit D (2000000Iu), vit E(10gm), vit K_3 (2gm), vit B_1 (1gm), vit B_2 (5gm), vitB_6 (1.5gm), vit B_{12} (10gm), nicotinic acid (30gm), pantothinic acid (10gm), folic acid (1gm), biotin (50mg), choline chloride50% (250gm), iron (30gm), copper (10gm), zinc (50gm), managese (60gm), iodine (1gm), selenium (0.1gm), cobalt (0.1gm) and carrier Q. S up to 2.5kg**.** **4-** Lysine 87% produced by Archar Daniels method company De Caur LL. Made in U. S. A. 5- DL-methionine produced by Evoink Co. Guranted analysis 99.5% DL-methionine**.** 6- Choline: choline chloride 60% with vegetable carrier (corn powder) produced by Shandyuong pharmaceutical Co. Chin. 7- Beta-2-x. 8- Nitrogen free extract calculated by difference. 9- methionine, lysine and ME were calculated according to NRC (1994)

Table (2): Experimental design during growing period.

Groups No.	Experimental diet No.	Protein %	Calcium %
1	1	24%	0.8%
2	2	--	1.0%
3	3	--	1.2 %
4	4	21%	0.8%
5	5	--	1.0%
6	6	--	1.2%

3. RESULTS AND DISCUSSION

Body weight development: Effect of various dietary protein and calcium levels on body weight development of growing Japanese quail is presented in table 3. Statistical analysis of the obtained data revealed that no significance (P≥0.05) between body weight of different experimental groups at the start of the experimental period (2nd week of chick age). Within aging of quail chicks it was observed that higher protein content with 0.8% calcium significantly (P≤0.05) improved body weight (BW) at 3rd and non significantly (P≥0.05) increased BW at 4th weeks of quail chick by about 13.1% and 3.0% respectively when compared with quail chick group fed on the same calcium level and lower protein (21%) content, however at the end of the experimental period it was observed that no significant effect of protein level in the Japanese quail diet on body weight. These result confirmed that Japanese quail chicks require high dietary protein content (24%) during both starter and grower period (up to 4th week of age) to maximize growth weight development while, require low protein (21%) during finisher period of development (during 5th and 6th week of chick age). These data are supported by those obtained by Gheisari et al. (2011) who indicated that body weight of quail chicks particularly at early age (14 and 28 days) was significantly influenced by dietary protein level (P< 0.05). Mean body weight in the high protein group was higher than medium, low and particularly very low protein groups (P < 0.05). Whereas, these differences in the body weights were not reflected on day 49 of life , being similar in high, medium and low protein groups.

Regarding dietary calcium levels of Japanese quail chick diets, it was observed that 25% or 50% higher calcium than recommended NRC requirement significantly (p≤0.05) reduced body weight at 3rd week of quail chick fed on 24% crude protein content by about 10.1% and 10.7% respectively when compared with quail chick group fed on the same protein level with standard calcium. In contrast, 25% or 50% higher calcium level with lower protein content non significantly (P≥0.05) improved body weight by about 2.1% and 2.3% respectively when compared with quail chick group fed on the same crude protein containing diet with 0.8% calcium content.

Moreover, it was observed that both higher calcium inclusion in Japanese quail chicken ration containing either 24 or 21% protein significantly (P≤0.05) improved quail chick body weight at the end of the experimental period by about (6.1% and 10.2%) and (9.4% and 9.3%) respectively when compared with quail chick group fed on the experimental diet containing the same crude protein level with the standard calcium. The obtained data revealed that Japanese quail chick required 0.8% calcium in their diet at the start and growing period (one day old up to 4th week of age), while the best productive performance during finisher period required 25% higher calcium level. This explanation are supported by those obtained by Kamberi et al. (2007) who reported that different Ca and available phosphorus (ap) levels has significantly affected weight gain of quails after 7 day of feeding (P=0.0001), but with the age quails have compensated this negative effect (P=0.4062) at the end of experiment.

Table (3): Effect of various dietary protein and calcium levels on body weight development (g/bird) of growing Japanese quail.

AGE/WEEK	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
2 week	24	68.98 ± 0.94^{ax}	67.91 ± 0.95^{ax}	68.38 ± 0.96^{ax}
	21	68.77 ± 1.00^{ax}	68.75 ± 0.91^{ax}	68.85 ± 0.83^{ax}
3 week	24	105.56 ± 1.34^{ax}	94.92 ± 1.32^{ay}	94.29 ± 1.50^{ay}
	21	93.30 ± 1.30^{bx}	95.22 ± 1.31^{ax}	95.45 ± 1.16^{ax}
4 week	24	147.70 ± 1.80^{ax}	143.97 ± 1.98^{ax}	146.88 ± 2.28^{ax}
	21	143.42 ± 1.98^{ay}	147.97 ± 1.99^{axy}	151.19 ± 1.62^{ax}
5 week	24	165.65 ± 2.16^{ay}	167.35 ± 2.28^{ay}	176.73 ± 2.62^{ax}
	21	163.96 ± 2.18^{ay}	167.52 ± 2.12^{ay}	178.07 ± 1.88^{ax}
6 week	24	181.55 ± 2.66^{ay}	192.60 ± 2.91^{bx}	200.05 ± 2.89^{ax}
	21	184.16 ± 2.72^{ay}	201.53 ± 2.74^{ax}	201.24 ± 2.62^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at (P≤0.05).

Growth performance parameters: Effect of various dietary protein and calcium levels on some growth performance and feed efficiency parameters of growing Japanese quail are presented in table 4. Statistical analysis of the obtained data indicated that higher protein feeding non significantly reduced total body gain by about 2.4% when compared with quail chicks group fed on lower protein diet. Our results are in agreement with those obtained by Shim & Vohra (1984) who recommended that 24% CP in diets for growing Japanese quails, which could be lowered to 20% after three weeks of age. Moreover, 25% or 50% high calcium more than recommended requirement with high or low protein diet significantly increased total gain by about (10.8% and 16.9%) and (15.1% and 14.7%) respectively when compared with growing chicks group fed on the same protein level with standard calcium content.

It was observed that lower protein content with standard calcium level increased average feed intake (AFI) throughout the whole growing period by about 1% when compared with chick group fed on the same calcium levels with higher protein content. It can be concluded that feed intake of Japanese quail chicks during growing period increased with lowering protein content and higher calorie/protein ratio. Bregendhal et al. **(2002)** reported that increasing dietary crude protein decreased the feed intake.Higher calcium levels in growing Japanese diet by about 25% or 50% than the recommended requirement increased total feed intake throughout the whole experimental period by about (5.6% and 24.1%) and (3.4% and 8.8%) respectively when compared with chick group fed on the same protein (24 or 21%) containing diet respectively. The possible explantiantion for increasing feed with higher inclusion levels of calcium may be attributed to calcium reduces metaboizable energy of the diet through combination with dietary fat forming insoluble soap. The present data are supported by those obtained by Salarmoini and Golian (2009) who concluded that higher calcium level in diet significantly ($P \leq 0.05$) reduced true metabolizable energy (TME) values of dietary fat as compared with low calcium diet.

Also, higher protein deteriorate FCR and PER when compared with growing chicks group fed on low protein diet, while 25% or 50% higher calcium improved both parameters when compared with group fed on the same protein level with standard calcium content. The best FCR and PER values were obtained by growing chicks group fed on low protein diet with 25% higher calcium and the worst values obtained by group fed high protein and 50% higher calcium diet.

Table (4): Effect of various dietary protein and calcium levels on some growth performance and feed efficiency parameters of growing Japanese quail.

PERIOD	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
Initial body weight (g/chick)	24	68.98 ± 0.94^{ax}	67.91 ± 0.95^{ax}	68.38 ± 0.96^{ax}
	21	68.77 ± 1.00^{ax}	68.75 ± 0.91^{ax}	68.85 ± 0.83^{ax}
Final weight (g/chick)	24	181.55 ± 2.66^{ay}	192.60 ± 2.91^{bx}	200.05 ± 2.89^{ax}
	21	184.16 ± 2.72^{ay}	201.53 ± 2.74^{ax}	201.24 ± 2.62^{ax}
Total body gain (g/bird)	24	112.57 ± 1.73^{az}	124.69 ± 1.98^{by}	131.67 ± 1.94^{ax}
	21	115.39 ± 1.74^{ay}	132.78 ± 1.84^{ax}	132.39 ± 1.80^{ax}
Daily body gain (g/bird/day)	24	4.02	4.45	4.70
	21	4.12	4.74	4.73
Total Feed intake (g/bird)	24	587.10	620.00	728.40
	21	593.00	613.60	645.90
Average feed conversion ratio	24	5.33 ± 0.08^{ay}	5.09 ± 0.07^{az}	5.64 ± 0.08^{ax}
	21	5.25 ± 0.08^{ax}	4.70 ± 0.06^{bz}	4.97 ± 0.07^{by}
Average protein efficiency ratio	24	0.80 ± 0.01^{by}	0.86 ± 0.01^{bx}	0.73 ± 0.01^{bz}
	21	0.93 ± 0.01^{ay}	1.02 ± 0.01^{ax}	1.00 ± 0.01^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at ($P \leq 0.05$).

Blood picture: Effect of various dietary protein and calcium levels on blood picture values of growing Japanese quail chicks are presented in table 5. Statistical analysis of the obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets non significant ($P \geq 0.05$) increased total RBCs counts, haemoglobulin percent (Hb) and packed cell volume (PCV) by about 1.2%, 3.7% and 2.2% respectively when compared with quail chick group fed on lower protein containing diet with the same level of calcium. On the other hand higher protein content non significantly decreased total WBCs counts when compared with quail chick group fed on diet contain low level of protein.

The obtained data are in accordance with those obtained by Tuleun et al. (2013) who stated that the hematological parameters showed that the highest values was obtained for packed cell volume, hemoglobin concentration, and total erythrocyte count in the laying quail hens placed on 21 % CP while the lowest value ($p < 0.05$) was recorded in the group of quail placed on 17 % CP. Also Mohamed et al. (2012) who confirmed that the dietary protein level had no significant effect ($P<0.05$) on Hb concentration of broiler chicken. This can be justified by the fact that supplementation of dietary protein level may leads to increase the globin part of the hemoglobin but not the haem part (Shahidullah et al., 2008).

Blood serum units: Effect of various dietary protein and calcium levels on some blood serum biochemical parameters of growing Japanese quail are presented in table 6. Statistical analysis of the obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets non significant ($P \geq 0.05$) increased serum total protein, albumin and globulin concentrations by about 7.2%, 3.4% and 20.9% respectively when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. Higher serum globulin concentration with nearly similar blood serum albumin concentration with higher protein feeding reflected on reduction of albumin/globulin ratio when compared with quail chicks group fed on low protein level with standard calcium content. This result was in contrast with Mosaad and Iben (2009) who suggested that Total protein, calcium and phosphorus in the serum of growing Japanese quail were significantly increased with the higher dietary crude protein levels but the serum glucose showed non significant increase with increasing dietary protein levels (21%, 24% and 27%) levels. Also Sharifi et al. (2011) observed that high dietary protein levels (24%) non significantly increased serum total protein level than low protein levels (22.08%). The difference may be related to the previous studies used higher dietary protein than mentioned in our experiment.

Regarding calcium levels in quail chick ration, it was observed that 25% or 50% high calcium with high protein content or low protein diet had no significant ($P \geq 0.05$) effect on blood serum total protein, albumin and globulin concentrations when compared with quail chicks group fed on the same protein level with standard calcium content. On the other hand, it was observed that both dietary protein or calcium levels in quail chick diets had no significant effect on blood serum glucose concentration, but lower protein level fed chicks exhibited numerically higher blood serum glucose concentration when compared with higher protein fed group. The present result are in harmony with those obtained by Mosaad et al. (2009) who indicated that dietary protein levels had no significant effect on blood serum glucose concentration in growing quail chicks.

Regarding blood serum calcium and phosphorus concentrations, it was observed that higher protein diet with standard calcium level increased ($P \geq 0.05$) both calcium and phosphorus blood serum concentration by about 6.8% and 65.1% respectively, when compared with quail chicks group fed on low protein diet with standard calcium level. Moreover 25% or 50% higher calcium with high or low protein feeding non significantly reduced blood serum calcium while, non significantly increased blood serum phosphorus concentration when compared with quail chicks group fed on the same protein level and standard calcium diet. Our data are supported by those obtained by (Mosaad and Iben, 2009 and Mosaad et al., 2009) they reported that blood serum calcium and inorganic phosphorous were increased with increasing quail dietary protein levels.

Table (5): Effect of various dietary protein and calcium levels on some blood picture values of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
RBCs ($x10^6/mm^3$)	24	1.70 ± 0.09^{ax}	1.73 ± 0.10^{ax}	1.60 ± 0.11^{ax}
count	21	1.68 ± 0.05^{ax}	1.73 ± 0.12^{ax}	1.58 ± 0.05^{ax}
TWBCs ($x10^3/mm^3$)	24	26.80 ± 0.69^{ay}	32.40 ± 1.20^{ax}	27.93 ± 1.09^{axy}
count	21	26.95 ± 1.77^{ax}	28.00 ± 2.88^{ax}	25.20 ± 2.18^{ax}
Hb%	24	7.60 ± 0.51^{ax}	7.50 ± 0.73^{ax}	8.70 ± 0.59^{ax}
	21	7.33 ± 0.74^{ax}	9.20 ± 0.55^{ax}	7.28 ± 0.60^{ax}
PCV	24	28.48 ± 0.40^{ax}	28.25 ± 0.63^{ax}	28.70 ± 1.32^{ax}
	21	27.88 ± 1.03^{ax}	27.77 ± 0.49^{ax}	28.05 ± 0.56^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at ($P\leq0.05$).

Table (6): Effect of various dietary protein and calcium levels on some blood serum biochemical parameters of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
Total protein	24	6.70 ± 0.07^{ax}	6.28 ± 0.08^{ax}	6.13 ± 0.06^{ax}
(g/dl)	21	6.25 ± 0.06^{ax}	6.23 ± 0.03^{ax}	6.23 ± 0.08^{ax}
Albumin (g/dl)	24	3.96 ± 0.12^{ax}	3.94 ± 0.11^{ax}	3.90 ± 0.08^{ax}
	21	3.83 ± 0.05^{ax}	3.96 ± 0.09^{ax}	4.02 ± 0.07^{ax}
Globulin (g/dl)	24	2.94 ± 0.15^{ax}	2.24 ± 0.13^{ax}	2.23 ± 0.06^{ax}
	21	2.43 ± 0.05^{ax}	2.26 ± 0.09^{ax}	2.22 ± 0.06^{ax}
A/G ratio	24	1.37 ± 0.19^{ax}	1.77 ± 0.15^{ax}	1.76 ± 0.08^{ax}
	21	1.58 ± 0.04^{ax}	1.76 ± 0.10^{ax}	1.82 ± 0.07^{ax}
Glucose (mg/dl)	24	86.02 ± 12.67^{ax}	87.98 ± 35.28^{bx}	101.46 ± 6.72^{ax}
	21	146.65 ± 8.67^{axy}	166.75 ± 22.59^{ax}	97.58 ± 14.31^{ay}
Calcium (mg/dl)	24	13.27 ± 1.25^{ax}	11.83 ± 0.97^{ax}	12.39 ± 1.67^{ax}
	21	12.42 ± 0.48^{ax}	10.61 ± 0.24^{ax}	11.04 ± 1.24^{ax}
Phosphorus	24	5.02 ± 0.80^{ax}	5.21 ± 0.46^{ax}	5.47 ± 0.36^{ax}
(mg/dl)	21	3.04 ± 0.25^{ax}	4.36 ± 0.08^{ax}	4.81 ± 1.41^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at ($P\leq0.05$).

Blood serum lipids concentrations: Effect of various dietary protein and calcium levels on some blood serum lipid concentrations of growing Japanese quail are presented in table 7. Statistical analysis of the obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets non significant ($P\geq0.05$) increased serum triglycerides and LDL by about 4.0% and 2.0% respectively when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. On the other hand higher protein content non significantly decreased serum total cholesterol and HDL levels by about 1.5% and 4.8% respectively when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. The present data are supported by

those obtained by Mosaad et al. (2009) they concluded that protein levels in Japanese quail diet had no significant effect on serum triglycerides and cholesterol concentrations.

On the other hand these data are in disagreement with Mosaad and Iben, (2009) who suggested high dietary protein levels (27%) non significantly decreased serum cholesterol level than medium levels (24% CP) but medium dietary protein levels non significantly increased serum cholesterol level than low protein levels (21%). Also Sharifi et al. (2011) observed that high dietary protein levels (24%) non significantly increased serum cholesterol and HDL levels but non significantly decreased serum triglyceride and LDL level than low protein levels (22.08%). This difference may be related to that authors used high protein diet than our diet.

Regarding calcium levels in quail chick ration, it was observed that 25% or 50% high calcium with high protein content non significantly decreased serum triglyceride level by about 0.3% or 3.0% but with low protein content non significantly increased serum triglyceride level by about 3.2% and 0.3% when compared with quail chick fed on same protein level with standard calcium content. Contrary higher dietary calcium level(1.0% - 1.2%) with high and low protein content non significantly reduced serum total cholesterol level than the diet with the same protein level with standard calcium content by about (1.7% - 0.8%) and (0.7% - 0.8%) respectively this may be due to increasing dietary calcium led to that calcium binding with fat forming calcium soap so decrease lipid absorption so decrease serum triglyceride and cholesterol level. it was also observed that 25% high dietary calcium(1.0%) with high protein content non significantly decreased serum HDL and LDL level by about 6.9%% and 2.6% but with low protein content non significantly increased serum HDL and LDL level by about 7.1% and 1.8% when compared with quail chick fed on same protein level with standard (0.8%) calcium content. So concluded that the lowest levels of serum HDL and LDL were seen at 1.0% dietary calcium level with high protein content (24%), however the highest levels of serum HDL and LDL were seen at 1.2% dietary calcium level with high protein content (24%). **Liver and Kidney functions blood serum parameters:** Effect of various dietary protein and calcium levels on some blood serum parameters related to liver and kidney functions of growing Japanese quail are presented in table 8. Regarding liver function parameters, it was observed that protein level in growing quail diet had no significant effect on blood serum GOT and GPT concentrations. Moreover 25% higher calcium with both high and low protein had no significant effect on blood serum GOT and GPT concentrations when compared with compared with quail chicks group fed on the same protein level with standard calcium content. However, 50% calcium higher than recommended requirement non significantly increased GOT and GPT blood serum concentration when fed with low protein content while had no clear effect when included with high protein level. The data revealed that higher calcium content (1.2) must be avoided in growing quail ration to protect hepatic cells and keep it in healthy condition.

Regarding renal function parameters, it was observed that higher protein feeding with standard calcium level non significantly ($P \geq 0.05$) increased blood serum uric acid and creatinine concentrations by about

Table (7): Effect of various dietary protein and calcium levels on some blood serum lipid concentrations of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
Triglycerides	24	218.05 ± 2.14^{ax}	217.48 ± 0.95^{ax}	211.53 ± 4.73^{ax}
(mg/dl)	21	209.60 ± 10.71^{ax}	216.35 ± 1.51^{ax}	210.18 ± 5.32^{ax}
Total cholesterol	24	196.33 ± 6.84^{ax}	192.67 ± 8.41^{ax}	194.67 ± 4.06^{ax}
(mg/dl)	21	199.33 ± 6.06^{ax}	198.00 ± 4.58^{ax}	197.67 ± 6.77^{ax}
HDL (mg/dl)	24	53.33 ± 4.41^{ax}	49.67 ± 7.45^{ax}	66.33 ± 5.36^{ax}
	21	56.00 ± 5.13^{ax}	60.00 ± 8.33^{ax}	56.00 ± 6.03^{ax}
LDL (mg/dl)	24	153.67 ± 7.31^{ax}	149.67 ± 3.28^{ax}	157.67 ± 9.70^{ax}
	21	150.67 ± 3.84^{ax}	153.33 ± 11.57^{ax}	152.67 ± 5.78^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at ($P \leq 0.05$).

0.4% and 80.9% respectively, when compared with quail chick group fed on the same calcium level with lower protein content. Moreover, inclusion of 25% or 50% calcium higher than recommended requirement with high or low protein diet increased (P≥0.05) blood serum concentration by about (19.2% and 36.7%) and (6.1% and 3.9%) respectively when compared with chicks group fed on the same level of protein with standard calcium content. However, higher calcium reduced creatinine blood serum concentration in quail chick fed on high protein diet and increased with low protein feeding. These data are supported by those obtained by Mosaad et al. (2009) who reported that blood serum uric acid concentration in growing chicks increased significantly with higher protein diets. Also, our results are in agreement with Sharifi et al, 2011 whoobserved that high dietary protein levels (24%) non significantly increased serum uric acid level than low protein levels (22.08%). From the obtained data, it can be concluded that high dietary protein and 50% higher calcium than requirement during finisher period deteriorate kidney function and the protein and calcium recommendation to safeguard the bad effect are 21% and 1.0 respectively.

Differential leucocytic counts: Effects of various dietary protein and calcium levels on differential leucocytic counts of growing Japanese quail are presented in table 9. Statistical analysis of the obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets non significant (P≥0.05) reduced lymphocytes and basophile percentage by about 16.8% and 0.6% when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. On the other hand higher protein feeding with standard calcium content of growing Japanese quail chick diets non significant (P≥0.05) increased easinophile, monocytes and neutrophile percentage by about 9.5%, 0.3% and 0.4% respectively, when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. Higher neutrophile percentage may be reflecting on higher immune response of quail chicks fed on high protein content compared with low protein feeding group.

Regarding calcium levels in quail chick ration, it was observed that 25% and 50% high calcium with high or low protein content non significantly (P≥0.05) reduced lymphocytes percentage by about (2.4% and 0.2%) or (11.3% and 7.1%) and monocytes percentage by about (0.1% and 17.8%) or (9.3% and 7.6%) respectively, when compared with quail chick fed on same protein level with standard calcium content. On the other hand 25% and 50% high calcium with high or low protein content non significantly (P≥0.05) increased easinophile percentage by about (5.4% and 6.0%) or (8.0% and 4.7%) and neutrophile percentage by about (0.3% and 7.6%) or (4.3% and 2.4%) when compared with quail chick fed on same protein level with standard calcium content. There was unclear effect of different calcium levels with high protein content on basophile percentage, but 25% and 50% high calcium with low protein level non significantly reduced basophile percentage when compared with quail chick fed on same protein level with standard calcium content. The present data revealed that 25% high calcium than NRC recommendation may be improve immune response of Japanese quail chicks and that conclusion require further investigation for proof the result..

Table (8): Effect of various dietary protein and calcium levels on some blood serum parameters related to liver and kidney functions of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
GOT (µ/L)	24	37.75±6.09^{ax}	36.50±7.96^{ax}	32.75±7.39^{ax}
	21	39.75±13.15^{ax}	40.25±17.29^{ax}	52.75±14.20^{ax}
GPT (µ/L)	24	27.00±6.12^{ax}	28.00±4.04^{ax}	25.00±1.41^{ax}
	21	24.25±1.31^{ax}	32.75±18.46^{ax}	42.50±11.41^{ax}
Uric acid (mg/dl)	24	5.72±0.14^{ax}	5.83±0.14^{ax}	5.93±0.11^{ax}
	21	5.70±0.13^{ax}	6.05±0.02^{ax}	5.92±0.11^{ax}
Creatinine (mg/dl)	24	2.95±0.97^{ax}	1.95±0.78^{ax}	2.13±0.75^{ax}
	21	1.63±0.43^{ax}	1.63±0.43^{ax}	3.63±1.10^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at (P≤0.05).

Table (9): Effect of various dietary protein and calcium levels on differential leucocytic counts of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
Lymphocytes (%)	24	21.95±0.99^{ax}	21.43±0.91^{ax}	21.90±1.97^{ax}
	21	26.38±1.15^{ax}	23.40±0.61^{ax}	24.50±3.09^{ax}
Basophile (%)	24	5.30±1.03^{ax}	3.40±0.77^{ax}	5.55±0.59^{ax}
	21	5.33±0.91^{ax}	4.53±0.87^{ax}	4.23±1.10^{ax}
Easinophile (%)	24	13.28±0.59^{ax}	14.00±1.35^{ax}	14.08±2.46^{ax}
	21	12.13±1.09^{ax}	13.10±1.33^{ax}	12.70±0.99^{ax}
Monocytes (%)	24	17.15±1.47^{ax}	17.13±1.63^{ax}	14.10±0.87^{ax}
	21	17.10±1.69^{ax}	15.50±1.60^{ax}	15.80±1.07^{ax}
Neutrophile (%)	24	42.08±1.98^{ax}	42.20±2.28^{ax}	45.28±1.00^{ax}
	21	41.90±4.07^{ax}	43.70±2.36^{ax}	42.93±2.17^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at (P≤0.05).

Table (10): Effect of various dietary protein and calcium levels on phagocytic activity and index of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
Phagocytic activity (%)	24	50.80±0.88^{ax}	51.68±0.99^{ax}	54.13±1.80^{ax}
	21	48.80±3.78^{ax}	52.37±2.37^{ax}	49.65±1.48^{ax}
Phagocytic index	24	3.31±0.22^{ax}	3.28±0.17^{ax}	3.21±0.09^{ax}
	21	3.12±0.07^{ax}	3.25±0.20^{ax}	3.17±0.20^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at (P≤0.05).

Phagocytosis: Effect of various dietary protein and calcium levels on phagocytic activity and index of growing Japanese quail are presented in table 10. Statistical analysis of the obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets non significant (P≥0.05) increased phagocytic activity and index by about 4.1% and 6.1% respectively, when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. Regarding calcium levels in quail chick ration, it was observed that 25% and 50% high calcium with high or low protein content non significantly (P≥0.05) increased phagocytic activity by about(1.7% and 6.5%) or (7.3% and 1.7%) respectively, when compared with quail chick fed on same protein level with standard calcium content. However 25% and 50% high calcium with high protein content non significantly (P≥0.05) decreased phagocytic index by about 0.9% and 3.0% but with low protein content non significantly (P≥0.05) increased phagocytic index by about 4.2% and 1.6%when compared with quail chick fed on same protein level with standard calcium content.

Immune organs weights: Effect of various dietary protein and calcium levels on immune organs weight and relative weights of growing Japanese quail are presented in table 11. Statistical analysis of the obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets non significantly (P≥0.05) decreased bursa weight, bursa relative weight, thymus gland weight and thymus gland relative weight by about 52%, 46.1%, 53.5% and 43.5% respectively, when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. However, higher protein feeding with standard

calcium content of growing Japanese quail chick diets non significant (P≥0.05) improved spleen weight and spleen relative weight by about 20 % and 37.5% respectively, when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. The present data are in contrast with those obtained by Mosaad et al. (2009) who reported that dietary protein levels had no significant (P≥0.05) effect on the internal organ weights.

Regarding calcium levels in quail chick ration, it was observed that 25% or 50% high calcium with high protein content non significantly (P≥0.05) increased bursa weight, bursa relative weight, thymus gland weight and thymus gland relative weight by about (25% or 108.3%), (28.6% or 85.7%), (15% or 65%) and (0.0% or 23.1%) but non significantly (P≥0.05) decreased spleen weight and spleen relative weight by about (27.8% or 16.7%) and (36.4% or 27.3%) respectively, when compared with quail chick fed on same protein level with standard calcium content. However 25% or 50% high calcium with high protein content non significantly (P≥0.05) reduced bursa weight, bursa relative weight, thymus gland weight, thymus gland relative weight, spleen weight and spleen relative weight by about (28%), (23.1% or 30.8%), (7% or 41.9%), (0.0% or 43.5%), (40.0% or 0.0%) and (25.0% or 0.0%) respectively, when compared with quail chick fed on same protein level with standard calcium content. It can conclude that high calcium level (25%) over the recommended requirement with higher protein is recommended for Japanese quail diet to improve immune response and fighting infectious diseases.

Effect of various dietary protein and calcium levels on some carcass traits of Japanese quail. Effect of various dietary protein and calcium levels on some carcass traits of growing Japanese quail are presented in table 12. Statistical analysis of the obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets non significant (P≥0.05) decreased dressing%, gizzard weight, gizzard relative weight, proventriculus weight and heart weight by about 0.1%, 19.6%, 6.5%, 6.4 and 8.8% respectively, when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. On the other hand the higher protein feeding with standard calcium content of growing Japanese quail chick diets non significant (P≥0.05) increased liver weight, liver relative weight, proventriculus relative weight and heart relative weight by about 5.7%, 22.2%, 9.7% and 6.7% respectively, when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. This result in agreement with Sharifi et al, 2011 who observed that using different dietary protein levels led to no significant differences in carcass yields of growing Japanese quails. Alsoagree with Mosaad and Iben, 2009 who suggested that high and medium dietary protein levels (27% and 24%) non significantly (P≥0.01) increased Liver weight, proventriculus weight, gizzard weight and heart weight but they observed that higher protein levels significantly($p < 0.01$) increased dressing percentage than low protein levels (21%) which disagree with our result. Also this result in contrast with Siyadati *et al*, 2011who observed that low crude protein (21%) led to lowest carcass yield during the whole rearing period in Japanese quails.

Regarding calcium levels in quail chick ration, it was observed that 25% or 50% high calcium with high protein content non significantly (P≥0.05) increased dressing %, Liver weight, gizzard weight, proventriculus weight, proventriculus relative weight, heart weight and heart relative weight when compared with quail chick fed on same protein level with standard calcium content. The higher liver relative weight was obtained with diet contain 1.0% calcium and high protein level (24%) also with diet contain 0.8% or 1.0% calcium with low protein content (24%). The highest dressing % was seen with diet contain 1.0% calcium with high or low protein content. Gizzard relative weight was non significantly (P≥0.05) decreased with increasing dietary calcium level than standard with high dietary protein, however with low dietary protein content 1.0% dietary calcium led to the highest gizzard relative weight and the lowest heart relative weight (P≥0.05). Increasing dietary calcium level with low protein content led to non significant (P≥0.05) liver and gizzard weight decrease and non significant (P≥0.05) increasing in proventriculus weight, proventriculus relative weight and heart weight. The present data are supported by those obtained by (Talpur et al., 2012**)** reported that liver weight increased with increasing calcium levl in Japanese quail diet**.** Moreover, Aguda et al. (2013) they observed that there were significant differences (P<0.05) in live weight, slaughter weight, dressed weight, and the weights liver, heart, intestine, head, shank and drum stick with different calcium and available phosphorus in growing quail ration. The best dressed weight was also yielded by birds fed diets

containing 1.0%Ca+0.5%aP. This may be related to accumulation of minerals in the part of the quail body which can be confirmed by carcass analysis in further study.

Effect of various dietary protein and calcium levels on nutrient digestibility of Japanese quail. Effect of various dietary protein and calcium levels on nutrient digestibility of growing Japanese quail are represented in table 13. The obtained data revealed that higher protein feeding with standard calcium content of growing Japanese quail chick diets decreased Dry matter, Organic matter, Inorganic matter (ash), Crude protein, Ether extract, Crude fiber and nitrogen free extract digestibility by about 6.8%, 3.8%, 39.7, 0.17%, 1.8%, 7.9% and 3.7% when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. On the other hand the higher protein feeding with standard calcium content of growing Japanese quail chick diets increased calcium and Phosphorus digestibility by about 23.6% and 0.4% when compared with quail chick group fed on lower protein containing diet with the standard level of calcium. The obtained data are in harmony with those (Dowarah and Sethi, 2014 They stated that there are no significant (P 0.05) difference was observed in digestibility of dry matter (DM), ether extract (EE), N- retention and calcium balance amongst three levels of protein. Although, crude fiber (CF) digestibility was significantly (P≤0.05) highest in LP and MP fed groups. Whereas, available phosphorus balance was best (P≤0.05) observed with MP supplementation. Also, it was in accordance with others research results (Ding, 2003 & Ozek and Bahtiyarca, 2004) the reason was that the energy and nitrogen was balance in the diet with low protein content but this balance was broken in the diet with high protein content so decreased digestibility with high dietary protein content.

Regarding calcium levels in quail chick ration, it was observed that 25% or 50% high dietary calcium content with high and low protein levels increased dry matter and organic matter digestibility when compared with quail chicken group fed on the same level of protein with standard calcium content. However, inorganic matter, crude fiber and nitrogen free extract digestibility showed unclear line. Moreover, increasing calcium (25 or 50% higher than recommended requirement) level in the growing quail diets decreased crude protein and ether extract digestibility when compared with quail chick group fed on the same protein level with standard calcium content. The lower fat digestibility with higher calcium level may be related to higher calcium form fat – calcium soap and excreted outside and that explanation supported by those obtained by (Salarmoini and Golian, 2009) they reported that addition of calcium carbonate reduced metabolizable energy of fats and oils when compared with low calcium diet. Also. higher calcium inclusion in growing Japanese quail diet with high or low protein content had no clear effect on calcium or phosphorus digestibility when compared with quail chicks group fed on the same protein level with standard calcium content.

Table (11): Effect of various dietary protein and calcium levels on immune organs weight and relative weights of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
Bursa weight	24	0.12 ± 0.03^{ax}	0.15 ± 0.05^{ax}	0.25 ± 0.06^{ax}
	21	0.25 ± 0.03^{ax}	0.18 ± 0.03^{ax}	0.18 ± 0.05^{ax}
Bursa relative weight	24	0.07 ± 0.02^{ax}	0.09 ± 0.03^{ax}	0.13 ± 0.03^{ax}
	21	0.13 ± 0.02^{ax}	0.10 ± 0.01^{ax}	0.09 ± 0.02^{ax}
Thymus gland weight	24	0.20 ± 0.04^{bx}	0.23 ± 0.05^{bx}	0.33 ± 0.09^{ax}
	21	0.43 ± 0.05^{ax}	0.40 ± 0.04^{axy}	0.25 ± 0.03^{ay}
Thymus gland relative weight	24	0.13 ± 0.03^{bx}	0.13 ± 0.03^{bx}	0.16 ± 0.04^{ax}
	21	0.23 ± 0.03^{ax}	0.23 ± 0.02^{ax}	0.13 ± 0.02^{ay}
Spleen weight	24	0.18 ± 0.03^{ax}	0.13 ± 0.03^{ax}	0.15 ± 0.03^{ax}
	21	0.15 ± 0.03^{ax}	0.09 ± 0.00^{ax}	0.15 ± 0.03^{ax}
Spleen relative weight	24	0.11 ± 0.02^{ax}	0.07 ± 0.01^{ax}	0.08 ± 0.02^{ax}
	21	0.08 ± 0.01^{ax}	0.06 ± 0.00^{ax}	0.08 ± 0.01^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at (P≤0.05).

Table (12): Effect of various dietary protein and calcium levels on some carcass traits of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
Dressing %	24	67.36±1.28^{ax}	68.97±1.30^{ax}	71.60±5.24^{ax}
	21	67.45±0.72^{ax}	68.01±0.46^{ax}	66.71±0.49^{ax}
Liver weight	24	4.05±0.36^{ax}	4.60±0.31^{ax}	4.73±0.59^{ax}
	21	3.83±0.28^{ax}	3.83±0.44^{ax}	3.70±0.12^{ax}
Liver relative weight	24	2.48±0.12^{ax}	2.64±0.14^{ax}	2.36±0.34^{ax}
	21	2.03±0.12^{ax}	2.26±0.34^{ax}	1.96±0.09^{ax}
Gizzard weight	24	3.28±0.19^{bx}	3.40±0.13^{ax}	3.38±0.16^{ax}
	21	4.08±0.23^{ax}	3.83±0.36^{ax}	3.85±0.13^{ax}
Gizzard relative weight	24	2.02±0.09^{ax}	1.96±0.05^{ax}	1.68±0.11^{bx}
	21	2.16±0.05^{ax}	2.24±0.25^{ax}	2.03±0.03^{ax}
Provent. Weight	24	0.73±0.05^{ay}	0.80±0.04^{axy}	0.98±0.08^{ax}
	21	0.78±0.06^{ax}	0.78±0.05^{ax}	0.80±0.11^{ax}
Provent. Relative weight	24	0.45±0.03^{ax}	0.46±0.03^{ax}	0.49±0.05^{ax}
	21	0.41±0.03^{ax}	0.46±0.05^{ax}	0.42±0.05^{ax}
Heart weight	24	1.55±0.09^{ay}	1.75±0.10^{ay}	2.25±0.13^{ax}
	21	1.70±0.08^{axy}	1.43±0.13^{ay}	1.85±0.13^{bx}
Heart relative weight	24	0.96±0.03^{ax}	1.01±0.07^{ax}	1.12±0.09^{ax}
	21	0.90±0.02^{ax}	0.82±0.03^{bx}	0.97±0.04^{ax}

Values are means ± standard error. Mean values with different letters at the same column (a - c letters) or row (x – z letters) and period differ significantly at (P≤0.05).

Table (13): Effect of various dietary protein and calcium levels on nutrient digestibility of growing Japanese quail.

ITEMS	PROTEIN%	CALCIUM %		
		0.8	1.0	1.2
Dry matter digestibility	24	57.38	59.57	59.01
	21	61.56	63.71	65.107
Organic matter digestibility	24	65.5	69.49	71.7
	21	68.12	70.83	75.63
Inorganic matter digestibility (ash)	24	18.5	25.89	18.02
	21	30.7	9.4	31.2
Crude protein digestibility	24	96.02	95.29	95.15
	21	96.18	95.42	95.87
Ether extract digestibility	24	91.35	90.19	90.73
	21	93.08	91.56	90.65
Crude fiber digestibility	24	25.5	27.5	31.29
	21	27.7	20.46	33.62
Nitrogen free extract digest.	24	75.3	77.18	84.57
	21	78.2	75.8	86.05
Calcium digestibility	24	69.4	69.8	74.0
	21	56.16	68.27	63.24
Phosphorus digestibility	24	80.74	79.14	81.17
	21	80.42	83.3	81.06

Conclusion: From the obtained data can be concluded that 21% crude protein content with 25% higher calcium (1.0%) than recommended requirement in growing Japanese ration improve growth performance, feed efficiency parameters and immune response against infectious diseases.

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