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BIOLOGICAL PERFORMANCE OF GROWING JAPANESE QUAIL AS AFFECTED BY STOCKING DENSITY AND DIETARY PROTEIN LEVEL

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ABSTRACT

To investigate the effect of stocking density and dietary protein level on the biological performance of Japanese quails, a total number of 540 unsexed seven days-old of Japanese quail chicks were randomly distributed into 3x3 factorial arrangement, which contained three stocking densities (15; 20 and 25 bird/m2) with three dietary protein levels (21; 23 and 25 % CP for the starter period and 18; 20 and 22 % CP for the growing period). Obtained results showed that crowding affected negatively ($P<0.05$ or 0.01) growth traits. Growing quails reared in 20 birds /m^2 and fed the high level of crude protein showed the highest live body weight (111.3 g.), and body weight gain (93.4 g.) at 4 weeks and 1-4 weeks, respectively, but, they failed thereafter. Meanwhile, birds reared in the lowest density and fed any studied levels of dietary protein showed the highest growth traits during the different growing periods. Quails reared in 25 birds/m^2 recorded the lowest values of feed consumption at 4-7 weeks ($P<0.01$) and 1-7 weeks ($P<0.05$). Stocking density didn't show any significant effect on feed conversion during all stages of growing period. Birds fed the high level of protein had the highest values of feed consumption or feed conversion ($P<0.05$) at 4-7 weeks. The interaction effect (stocking density with protein level) was significant ($P<0.05$) on feed conversion through 1-4 or 4-7 weeks only. Birds reared in 20 birds /m^2 and fed high or low crude protein showed the lowest values of feed conversion through 1-4 weeks or 4-7 weeks, respectively.

In general, group of 15 birds/m^2 recorded higher values of plasma total protein and its fractions or A/G ratio either in males or females. Total protein and albumin significantly ($P<0.05$) increased as dietary protein level increases in both sexes. Plasma of female birds had higher values of total protein and its fractions or A/G ratio except plasma globulin, which was in lower values versus to those of males. No significant differences in total protein and its fractions or A/G ratio were observed due to the interaction effect in both sexes. Group of birds fed high protein level in the high density had higher values of cholesterol in both sexes. Although, the differences in this trait due to the interaction effects were significant ($P<0.01$) only in male birds. In both sexes, GOT activity was significantly ($P<0.01$) increased or decreased as stocking density or dietary protein level increased, respectively. Female birds of Japanese quails recorded slightly higher or nearly similar values of GOT and GPT enzymes activity as compared with those of male birds. Packed cell volume percentage (PCV%) was significantly ($P<0.01$) increased with the decreasing or increasing stocking density and protein level, respectively either in male or female, however, the interaction effect was insignificant. Values of PCV% in male birds were higher than those of female.

Edible parts Weight was significantly ($P<0.05$ or 0.01) increased with decreasing stocking density and increasing protein level except heart weight in both sexes and gizzard in males. Groups of 15 birds/m^2, which fed the higher level of protein, were accompanied by the highest weight of the edible parts ($P<0.05$ or 0.01). Female edible parts weight were heavier than those of males, except, the heart weight.

Keywords: Quail, biological performance, stocking density, dietary protein.

INTRODUCTION

Japanese quail is an interesting domesticated economical species for commercial valuable source of meat and eggs beside chickens. It is blessed with unique characteristics of fast growth; early sexual maturity; high rate of egg production; short generation interval and incubation period that make it very suitable as alternative farming animal (Shanaway, 1994). However, these biological advantages are affected by several factors such as species; sex; age; stocking density; nutrients intake; photoperiod and temperature. Stocking density is one of the most important factors which affect the biological performance (growth, feed utilization, blood parameters) of growing quails (Nagarajan *et al.*, 1991; Shanawany, 1994 and Bandyopadhyay et al 2000). Since, overcrowding causes a reduction in the available feeding and drinking space, which in turn leads to reducing feed intake. Dietary protein is considered the most important one of feed nutrients. Large differences in crude protein requirements of growing Japanese quails were observed in response to the physiological and environmental conditions (Annaka *et al.*, 1994). Using suitable stocking density and diet to optimize the biological performance of growing Japanese quails (consequently, maximizing the economical returns) is questionable.

The present study was designed to investigate the effect of stocking density and dietary protein level on the biological performance of quail broilers.

MATERIALS AND METHODS

A total number of 540 unsexed seven days old Japanese quail chicks were wing banded and randomly distributed into 3x3 factorial design. Which contain three stocking densities (15; 20 and 25 birds/m^2) with three levels of experimental dietary protein (21; 23 and 25 % CP for the starter period and 18; 20 and 22 % CP for the growing period).

All chicks were reared in electrical brooder up to 3 weeks of age at 35°C during the first week of age then gradually reduced to 28°C at the beginning of the third week of age. Birds were subjected to continuous lighting regime with free access to feed and water (ad-lb.). All chicks were kept under the same managerial; hygienic and environmental conditions. The composition and calculated chemical analysis of the experimental rations are presented in Table 1.

Individual body weights were recorded at the beginning of the experiment and at 4 or 7 weeks of age. Feed intake and feed conversion (feed/gain) were calculated during the certain periods.

At the end of the 7th weeks of old (end of the experiment), 4 males and 4 females of each experimental group were randomly chosen and scarified. During bleeding, blood samples were collected in heparinized tube. Hematocrit was determined using capillary tubes according to Winterobe (1967). Blood plasma was obtained by centrifuging the whole blood at 3000 rpm for 15 min. plasma was immediately stored at -20°C till analysis. Plasma total protein; albumin; cholesterol and transaminase enzymes activities (GOT, glutamic oxaloacetic transaminase and GPT, glutamic pyruvic transaminase) were determined colorimetrically using commercial kits purchased from Bio-Meriux, France. Globulin was calculated by subtracting the albumin values from the corresponding values of total protein.

Table 1. Composition and calculated chemical analysis of the experimental rations.

Items	Starter ration			Grower ration		
	Low protein	Moderate protein	High protein	Low protein	Moderate protein	High protein
Yellow corn	60.89	56.78	52.50	67.18	63.15	59.13
Soybean meal (44%)	24.20	24.55	25.61	22.47	25.00	26.00
Corn gluten (60%)	6.34	10.12	13.43	1.40	3.91	7.31
Wheat bran	5.18	5.28	5.30	5.41	4.545	4.30
Limeston	1.36	1.35	1.38	1.34	1.35	1.36
Di-Ca-P.	0.90	0.88	0.85	0.91	0.88	0.85
Dl-methionine	0.135	0.085	0.03	0.22	0.165	0.11
Lysine	0.395	0.355	0.30	0.47	0.40	0.34
Na Cl	0.30	0.30	0.30	0.30	0.30	0.30
Primex*	0.30	0.30	0.30	0.30	0.30	0.30
	100	100	100	100	100	100
Calculated **						
C.P.	20.99	23.00	25.00	17.96	20.00	22.00
M.E.	2906	2914	2913	2904	2902	2908
C.F.	3.69	3.68	3.71	3.66	3.69	3.69

Primex *: Each 1 kg contains: Vit A, 10,000, 000 IU, Vit. D3 1,100,000 IU, vit B1 400 mg, Vit. B2 600 mg, vit. B6 1, 200 mg, vit. B12 4.5 mg, vit. Bition 80 mg, Pantothenic acid 3250 mg, Vit. K3 1500 mg, Vit. C 1200 mg, Inositol 50 mg, Folic acid 50 mg, Choline Hcl 175,000 mg, Cobalt 120 mg, iron 15,000 mg, Manganese 35, 000 mg, Copper 1.25 mg, Zinc 31.25 mg, Iodine 500 mg, Selenium 50 mg and BHT 125 mg.
**** According to NRC (1994).**

Carcass traits (edible parts) were separated and weighed to the nearest gram for each sex alone.

Data were subjected to ANOVA using General Linear Model (GLM) procedure of SPSS program (1993) using the following model:

$$Y_{ijk} = \mu + D_i + P_j + DP_{ij} + e_{ijk}$$

Where,

Y_{ijk} = the whole observation on k^{th} bird.

μ = the common mean.

D_i = the fixed effect of i^{th} density (I: 1; 2 and 3).

P_j = the fixed effect of j^{th} level of protein (j: 1; 2 and 3).

DP_{ij} = the interaction effect of stocking density with dietary protein level (ij: 1;2;..... and 9).

e_{ijk} = The random error assumed to be independently randomly distributed.

Comparison between treatment means followed by Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Growth performance:

Results in Table 2, showed that crowding affected negatively ($P<0.05$ or 0.01) growth traits, since birds reared in 25 birds /m^2 had the lowest live body weight either at 4 or 7 weeks. However, the effect was in low magnitude at 4 weeks. Body weight gain followed the same trend of live body weight. Similar results were obtained by Das *et al.*, (1990); Lewis *et al.*, (1997); Ahuja *et al.*, (1998) and Ozcelik *et al.* (1999). The unfavorable effect of high stocking density may be attributed to the modification of the resting behavior due to the disturbances by the other birds, also, the decreasing of feed consumption (Table 3).

Body weight and body weight gain of quails fed the moderate dietary protein level tended to surpass those of the other dietary protein levels (low and high crude protein). However, this surpassing was significant ($P<0.05$ or 0.01) only for body weight gain at 1-4 or 4-7 weeks. The present findings were in agreement with those reported by Hyankova *et al.*, (1997) in growing quails; Soliman *et al.*, (1999) in broiler and Minoguchi *et al.*, (2000) in laying Japanese quails during the rearing period. The non definite trend that observed in body weight at 4 weeks in this study due to protein level effect was supported also by the findings mentioned by Oliveira *et al.*, (2002). Who, clarified that from 1 to 21 days of age, there was no evidence of the effect of dietary protein levels on body weight in growing quails. On the other hand, Alleman *et al.*, (2000) showed that increasing protein levels didn't affect body weight of broiler chicks between 28 and 49 days of age. Moreover, Abdel-Azeem *et al.*, (2001) reported insignificant effect for protein level on body gain through 3-6 or 0-6 weeks in growing Japanese quails. The positive effect of increasing protein level on growth performance might be due to increasing the amount of crude protein consumed (Table 3). Since, protein considers the most essential element of nutrients for growth. Among the proteins a lot of necessary constituents such as, enzymes; hormones; antibodies; hemeproteins; glycoproteins and lipoproteins (Wahba, 1969 and Murray *et al.*, 1991).

Quails reared in 20 birds /m^2 and fed the high level of crude protein showed the highest live body weight (111.3 g.) and body weight gain (93.4 g.) at 4 weeks and 1-4 weeks, respectively. At the last stage of growing period (4-7 weeks), this group of birds recorded a markedly deterioration in their growth traits. Meanwhile, birds reared in the lowest density and fed any studied levels of dietary protein showed the highest growth traits during all the growing periods and the highest body weight gain through the whole growing period (1-7 weeks). This may be due to the absence of density stress through the early stage of growing in the high-density groups, since birds still in small size, while birds in low-density group lost more energy during this stage in the movement through the large area space allowanced. In the later stage, time by time birds increases in body size, then density stress begin to exist in groups of high or medium density which cause the deterioration in growth performance.

Table 2. Effect of stocking density and dietary protein level and their interactions on live body weight and body weight gain (X±SE) of growing Japanese quails.

Items		Live body weight (g)			Body weight gain (g)		
		Initial	4-weeks	7-weeks	1-4 weeks	4-7 weeks	1-7 weeks
Stocking density		NS	*	**	*	**	**
15 birds/m^2		17.30±0.26	104.31±0.84^{a}	196.38±1088^{a}	86.92±0.92^{a}	92.07±2.03^{a}	179.00±1.88^{a}
20 birds/m^2		17.50±0.24	105.19±0.82^{a}	184.35±1.74^{b}	87.83±0.86^{a}	79.16±1.91^{b}	167.00±1.75^{b}
25 birds/m^2		17.50±0.16	102.12±0.64^{b}	171.45±1.38^{c}	84.76±0.66^{b}	69.33±1.51^{c}	154.09±1.41^{c}
Protein level %		NS	*	NS	*	**	NS
21		17.50±0.23	104.27±0.90^{a}	180.17±1.93	86.75±0.92^{a}	75.90±2.13^{b}	162.65±1.95
23		17.40±0.20	101.74±0.62^{b}	184.89±1.73	84.53±0.66^{b}	83.16±1.76^{a}	167.69±1.73
25		17.40±0.21	105.06±0.73^{a}	180.88±1.69	87.68±0.77^{a}	75.82±1.75^{b}	163.50±1.73
Interactions		NS	**	*	**	**	*
15 birds/m^2	21%	17.10±0.43	104.27±1.68^{bc}	198.73±3.80^{a}	87.20±1.84^{bc}	94.46±4.21^{a}	181.66±3.76^{a}
	23%	18.00±0.43	103.69±1.23^{bcd}	196.29±3.02^{a}	84.88±1.40^{cd}	92.60±3.18^{a}	177.48±3.00^{a}
	25%	16.80±0.37	104.96±1.41^{b}	194.11±2.94^{a}	88.67±1.50^{bc}	89.16±3.05^{ab}	177.82±3.00^{a}
20 birds/m^2	21%	17.60±0.45	100.62±1.86^{cde}	182.67±3.13^{b}	83.01±1.90^{d}	82.04±3.39^{bc}	165.05±3.13^{b}
	23%	17.00±0.34	103.63±1.80^{bcd}	191.12±2.76^{a}	87.09±0.93^{bc}	87.48±2.97^{ab}	174.57±2.81^{a}
	25%	17.90±0.42	111.30±1.00^{a}	179.27±2.96^{bc}	93.38±1.13^{a}	67.97±3.06^{de}	161.35±2.96^{bc}
25 birds/m^2	21%	17.70±0.32	107.17±1.08^{b}	167.03±2.27^{d}	89.47±1.09^{b}	59.86±2.43^{e}	149.33±2.33^{d}
	23%	17.30±0.21	99.05±1.05^{e}	173.08±2.42^{cd}	82.28±1.08^{d}	74.03±2.59^{cd}	156.31±2.45^{cd}
	25%	17.60±0.30	100.13±0.99^{de}	174.24±2.43^{cd}	82.53±1.06^{d}	74.11±2.53^{cd}	156.64±2.49^{bcd}

Means in the same column within each factors differently superscripted are significantly differed ($P<0.05$ or 0.01), ns = not significant.

Feed utilization:

Stocking density had a bad effect on feed intake, since, quails reared in 25 birds/m^2 recorded the lowest values of feed consumption. However, this effect was significant (P<0.01) only at 4-7 weeks and at (P<0.05) 1-7 weeks. Stocking density didn't show any significant effect on feed conversion during all stages of growing period (Table 3). These findings are in a closely agreement with the previous results on growing quails mentioned by Ahuja *et al.*, (1998) and Bandyopadhyay *et al.*, (2000). Feed consumption reduction may be due to the reduction in floor space, which increase the competition for positions at the feeder trough. In contrast, birds in lower density were allowed more movement, which may have resulted in less more movement that lead to less stressful environment (Davami *et al.*, 1986).

Dietary protein level didn't show any significant effect on feed utilization, except those during (4-7 weeks), since, group of birds fed the high level of protein had the highest values of feed consumption or feed conversion (P<0.05). Similar results were obtained also by Hyankova *et al.*, (1997) and Soliman *et al.*, (1999) who sayed that the high level of protein improved feed intake and feed conversion efficiency. Feed intake was not influenced by crude protein level, but feed conversion efficiency was significantly better due to the high crude protein level (Babu *et al.*, 1986 and Raju *et al.*, 1999).

The interaction effect (stocking density with protein level) didn't show any significance difference in feed consumption values while its effect was significant (P<0.05) for feed conversion through 1-4 and 4-7 weeks only. Birds group reared in 20 birds /m^2 and fed high or low crude protein showed the lowest values of feed conversion through 1-4 weeks or 4-7 weeks, respectively. In general, most of feed utilization parameters in the present work didn't affected by the interaction effect, except, feed conversion at 1-4 or 4-7 weeks, which affected at a low level of significance (P<0.05) that considered unexplainable.

Blood parameters:

Results in Tables 4&5 indicated that groups of 15 birds/m^2 recorded higher values of plasma total protein and its fractions or A/G ratio either in males or females. Although, the differences in these traits were significant (P<0.05 or 0.01) only for plasma albumin and A/G ratio (in males) and total protein or albumin (in females). Similar results were found in muscovi ducks by EL-Kaiaty *et al.*, (2001), they reported that density had a significant effect on total protein; albumin and globulin, since, values of these parameters were increased as population density decreases. On the other hand, Erisir and Erisir (2002) in quails failed to find any significant differences in albumin and total protein levels. As was mentioned before the high stocking density is considered as a stressor factor which in turn affects unfavorably the biological performance in general and protein synthesis in liver cells in special.

Table 3. Effect of stocking density and dietary protein level and their interactions on feed intake and feed conversion (X+SE) of growing Japanese quails.

Items		Feed intake (g)			Feed conversion (g)		
		1-4 weeks	4-7 weeks	1-7 weeks	1-4 weeks	4-7 weeks	1-7 weeks
Stocking density		NS	**	*	NS	NS	NS
15 birds/m^2		121.09±4.14	206.88±6.04^{a}	327.97±8.86^{a}	1.39±0.05	2.25±0.08	1.83±0.06
20 birds/m^2		120.57±4.16	179.72±8.67^{b}	300.29±11.42^{ab}	1.38±0.05	2.31±0.18	1.80±0.07
25 birds/m^2		115.90±3.08	167.56±6.51^{b}	283.46±8.51^{b}	1.37±0.04	2.44±0.11	1.84±0.06
Protein level %		NS	*	NS	NS	*	NS
21		114.94±2.79	173.66±9.96^{b}	288.60±10.37	1.33±0.14	2.25±0.14^{b}	1.75±0.06
23		120.79±4.18	182.61±7.40^{ab}	303.37±8.89	1.42±0.04	2.16±0.08^{b}	1.79±0.05
25		121.85±4.16	197.89±7.98^{a}	319.74±11.66	1.39±0.06	2.59±0.12^{a}	1.93±0.05
Interactions		NS	NS	NS	*	*	NS
15 birds/m^2	21%	113.50±5.63	207.31±8.31	320.81±13.94	1.30±0.08^{ab}	2.19±0.09^{bc}	1.77±0.09
	23%	117.56±4.71	196.67±9.16	314.23±17.83	1.39±1.00^{ab}	2.12±0.12^{bc}	1.77±0.11
	25%	132.23±5.11	216.66±8.04	348.89±15.77	1.49±0.06^{a}	2.43±0.16^{abc}	1.96±0.10
20 birds/m^2	21%	116.70±7.96	155.00±7.22	271.70±14.58	1.41±0.06^{ab}	1.89±0.14^{c}	1.65±0.10
	23%	131.67±5.07	185.83±9.31	317.50±13.46	1.51±0.05^{a}	2.13±0.16^{bc}	1.82±0.10
	25%	113.33±5.33	198.33±8.17	311.66±17.81	1.21±0.06^{b}	2.92±0.20^{a}	1.93±0.11
25 birds/m^2	21%	114.64±4.38	158.67±9.41	273.30±16.50	1.28±0.04^{ab}	2.66±0.22^{ab}	1.83±0.10
	23%	113.07±5.64	165.33±7.95	278.40±10.63	1.37±0.06^{ab}	2.24±0.18^{bc}	1.78±0.11
	25%	120.00±6.05	178.68±9.09	298.67±14.69	1.46±0.09^{a}	2.41±0.16^{abc}	1.91±0.11

Means in the same column within each factors differently superscripted are significantly differed ($P<0.05$ or 0.01), ns = not significant.

Table 4. Effect of stocking density and dietary protein level and their interactions on some blood chemical composition (X±SE) of growin Japanese quails (males).

Items		Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G Ratio	Cholesterol (mg/dl)	GOT (u/l)	GPT (u/l)	PCV%
Stocking density		Ns	**	Ns	*	**	**	Ns	**
15 birds/m^2		4.22±0.15	1.85±0.15^{a}	2.36±0.17	0.80±0.04^{a}	121.55±5.80^{c}	29.00±1.49^{c}	21.09±1.39	41.83±1.78^{a}
20 birds/m^2		4.01±0.15	1.57±0.14^{b}	2.45±0.14	0.64±0.03^{b}	133.97±5.28^{b}	34.32±2.13^{b}	21.27±1.38	40.26±1.54^{b}
25 birds/m^2		4.01±0.27	1.62±0.13^{b}	2.39±0.20	0.69±0.04^{b}	135.80±5.58^{a}	36.75±2.07^{a}	22.07±1.49	37.31±1.72^{c}
Protein level %		Ns	*	Ns	Ns	**	**	Ns	**
21		3.99±0.15	1.60±0.15^{b}	2.39±0.16	0.68±0.04	120.49±5.46^{c}	37.00±2.36^{a}	21.86±1.53	37.51±1.62^{c}
23		4.04±0.15	1.70±0.16^{ab}	2.34±0.17	0.74±0.05	130.53±4.53^{b}	32.93±1.99^{b}	21.44±1.39	39.57±1.66^{b}
25		4.21±0.19	1.74±0.14^{a}	2.47±0.19	0.72±0.03	140.29±5.10^{a}	30.24±1.71^{c}	21.12±1.36	42.32±1.70^{a}
Interactions		Ns	Ns	Ns	Ns	**	**	*	Ns
15 birds/m^2	21%	4.12±0.19	1.75±0.16	2.37±0.24	0.75±0.06	109.42±3.98^{g}	30.95±1.63^{e}	20.23±1.50^{b}	39.37±1.56^{a}
	23%	4.18±0.18	1.92±0.15	2.27±0.23	0.86±0.07	124.00±4.27^{f}	28.55±1.60^{fg}	20.99±1.83^{b}	41.17±1.67^{a}
	25%	4.34±0.17	1.89±0.17	2.45±0.24	0.78±0.07	131.23±4.35^{d}	27.79±1.31^{g}	22.06±1.43^{ab}	44.95±1.74^{a}
20 birds/m^2	21%	3.96±0.18	1.49±0.18	2.47±0.13	0.60±0.03	124.43±4.27^{f}	38.70±1.59^{b}	21.84±1.78^{ab}	38.15±1.47^{a}
	23%	4.01±0.18	1.55±0.19	2.46±0.24	0.64±0.06	135.08±3.36^{c}	34.40±1.58^{cd}	21.05±1.59^{b}	40.63±1.34^{a}
	25%	4.08±0.17	1.67±0.17	2.41±0.11	0.69±0.03	142.41±3.90^{b}	29.87±1.70^{ef}	20.91±1.66^{b}	42.00±1.61^{a}
25 birds/m^2	21%	3.88±0.19	1.56±0.16	2.33±0.25	0.68±0.07	127.63±3.86^{e}	41.36±1.47^{a}	23.52±1.61^{a}	35.01±1.58^{a}
	23%	3.93±0.19	1.34±0.14	2.29±0.24	0.73±0.06	132.53±4.34^{cd}	35.84±1.46^{c}	22.29±1.55^{ab}	36.92±1.83^{a}
	25%	4.21±0.36	1.67±0.15	2.55±0.36	0.67±0.06	147.24±3.89^{a}	33.07±1.44^{d}	20.40±1.60^{b}	40.00±1.63^{a}

Means in the same column within each factors differently superscripted are significantly differed ($P<0.05$ or 0.01), ns = not significant.

Table 5. Effect of stocking density and dietary protein level and their interactions on some blood chemical composition (X±SE) of growin Japanese quails (females).

	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	A/G Ratio	Cholesterol (mg/dl)	GOT (u/l)	GPT (u/l)	PCV%
Stocking density	**	**	Ns	Ns	**	**	Ns	**
15 birds/m^2	4.41±0.15^a	2.11±0.13^a	2.29±0.12	0.92±0.01	128.35±5.51^c	32.57±1.55^c	22.71±1.39	39.49±1.62^a
20 birds/m^2	4.17±0.15^b	1.96±0.16^b	2.22±0.16	0.90±0.04	138.64±5.54^b	35.92±2.21^b	22.82±1.50	37.90±1.58^b
25 birds/m^2	4.07±0.14^b	1.91±0.12^b	2.16±0.16	0.89±0.04	140.32±5.16^a	37.61±2.17^a	22.58±1.51	33.79±1.57^c
Protein level %	*	Ns	Ns	Ns	**	**	**	**
21	4.13±0.16^b	1.95±0.18	2.18±0.16	0.91±0.04	126.93±4.69^c	39.04±2.14^a	22.58±1.47^b	35.51±1.77^b
23	4.21±0.16^{ab}	1.99±0.14	2.22±0.16	0.91±0.03	134.50±4.85^b	35.43±1.58^b	23.65±1.32^a	36.46±1.79^b
25	4.31±0.16^a	2.04±0.16	2.27±0.13	0.90±0.01	145.88±4.49^a	31.64±1.46^c	21.88±1.44^a	39.21±1.86^a
Interactions	Ns	Ns	Ns	Ns	Ns	**	*	Ns
15 birds/m^2 21%	4.32±0.18	2.11±0.15	2.21±0.14	0.96±0.01	119.39±3.83	34.00±1.61^d	21.92±1.73^{bc}	38.05±1.43
23%	4.39±0.13	2.09±0.17	2.29±0.12	0.91±0.03	126.53±4.03	33.25±1.51^d	23.22±1.49^{ab}	38.43±1.61
25%	4.53±0.15	2.15±0.15	2.38±0.14	0.90±0.02	139.15±3.88	30.47±1.63^e	23.00±1.74^{abc}	41.99±1.74
20 birds/m^2 21%	4.02±0.19	1.90±0.18	2.12±0.25	0.92±0.09	129.58±4.04	40.71±1.69^b	24.02±1.58^a	36.12±1.65
23%	4.20±0.18	1.95±0.16	2.25±0.24	0.88±0.08	137.00±4.50	35.82±1.70^c	23.41±1.58^{ab}	37.84±1.73
25%	4.29±0.18	2.02±0.17	2.27±0.13	0.89±0.01	149.35±3.94	31.25±1.51^e	21.02±1.65^c	39.76±1.73
25 birds/m^2 21%	4.06±0.19	1.85±0.16	2.21±0.25	0.85±0.09	131.85±3.47	42.42±1.57^a	21.79±1.69^{bc}	32.37±1.57
23%	4.04±0.11	1.93±0.14	2.12±0.24	0.92±0.08	139.98±4.02	37.24±1.50^c	24.33±1.59^a	33.11±1.50
25%	4.12±0.15	1.95±0.19	2.17±0.12	0.90±0.04	149.14±3.57	33.22±1.54^d	21.61±1.67^{bc}	35.89±1.81

Means in the same column within each factors differently superscripted are significantly differed ($P<0.05$ or 0.01), ns = not significant.

Total protein and its fractions increased as dietary protein level increases in both sexes. The increase was significant ($P<0.05$) only for albumin and total protein in males and females (Tables 4&5). Other findings supported the present results (Abd El-Hady and Abd El-Ghany, 2003 in chicks and Mousa and Shetaewi, 2003 in rabbits) who reported that total protein; albumin and globulin increased significantly ($P<0.05$) by increasing dietary protein level. While, Abdel-Azeem *et al.*, (2001) didn't find any significant effect on plasma protein or its fractions in broiler chicks.

The present results (Tables 4 and 5) indicated that plasma of female birds had higher values of total protein and its fractions or A/G ratio except plasma globulin, which was in lower values versus to those of males. These results are in fairly agreement with those obtained by Abdel-Azeem *et al.*, (2001) who found that female quails had higher plasma protein and globulin concentrations as compared to those of males. The higher values of total protein in female quails might be due to the higher estrogenic effects in females (Sturkie, 1986). Other results in muscovi ducks (EL-Kaiaty *et al.*, 2001), showed that sex effects on total protein; albumin and globulin were insignificant. On the other hand, Ibrahim and Mobarak (2002) showed that total protein of Fayomi chicks was slightly higher in males (4.52 g/dl) than that of females (4.4 g/dl).

No significant differences in total protein and its fractions or A/G ratio were observed due to the effect of stocking density and protein level interaction in both sexes.

Plasma cholesterol content was significantly ($P<0.05$) increased as stocking density or protein level increased in both sexes. So, group of birds fed high protein level in the high density had the higher values of cholesterol in both sexes. Plasma cholesterol content of female birds was higher than that of male birds. Similar findings were mentioned for stocking density and sex effects by Kumar *et al.*, (2000) in quails and El-Kaiaty *et al.*, (2001) in muscovi ducks and for protein level effect by Abdel-Azeem *et al.*, (2001) in quails and Abd El-Hady and Abd El-Ghany (2003) in broiler chicks. While, plasma cholesterol of growing rabbits was decreased as dietary protein level increases (Mousa and Shetaewi, 2003). Moreover, sex had no significant correlation with serum cholesterol concentration of Japanese quails at 5 weeks of age (Nazifi *et al.*, 2000).

In both sexes, GOT activity was significantly ($P<0.01$) increased or decreased as stocking density or dietary protein level increased, respectively. Since group of 25 bird/m^2 that fed the lowest protein level had the highest value of GOT activity (Tables 4&5). Regarding the activity of GPT enzyme, there is no definite trend in the activity values due to the effect of either stocking density or protein level, irrespective of the significant difference in this trait due to the interaction effect in both sexes and dietary protein level effect in female quails. No significant differences were observed in the activities of the two enzymes due to the effect of stocking density in muscovi ducks (EL-Kaiaty *et al.*, 2001) and dietary protein level effects in growing Japanese quails (Abdel-Azeem *et al.*, 2001). However, the later author came to the same trend of the present study for GOT activity. The conflicting between the present results and those of the previously mentioned investigators may be due to the difference in species of birds; the levels of the protein used or the environmental conditions. The short range of difference in the activities of the two enzymes among treatment groups indicate that stocking densities and levels of dietary protein used in the present work had non-hepatic effects. Since, GOT and GPT enzymes release depends upon sensitive of liver cells; hepatic damage (Mandour *et al.,* 1995).

Females of Japanese quail recorded slightly higher or nearly similar values of GOT and GPT enzymes activity as compared with those of male birds. The present results were in a closely agreement with those obtained by several investigators (Nazifi *et al.,* 2000; Abdel-Azeem *et al.,* 2001 and Ibrahim *and* Mobarak, 2002) in growing quails and El-Kaiaty *et al.,*(2001) in muscovi ducks. In general, the differences in plasma constituents due to sex effect in the present work may be attributed to the differences between the of male and female quails responses to stocking density (Erisir and Erisir, 2002).

Results in (Tables 4&5) showed that packed cell volume percentage (PCV%) was significantly (P<0.01) increased with the decreasing or increasing stocking density and protein level, respectively either in male or female, however, the interaction effect was insignificant. Values of PCV% in male birds of broiler quails were higher than those of female birds. Similar findings to those of this work were reported in growing quails by (Abdel-Azeem *et al.*, 2001), who mentioned that PCV% was increased as dietary protein level increases. Also, the same author and EL-Kaiaty *et al.*, (2001) reported higher values of PCV% in male birds versus those of female birds. In contrary, other workers showed that stocking density and sex didn't affect PCV% in muscovi ducks (EL-Kaiaty *et al.*, 200l) and in growing quails (Ibrahim and Mobarak, 2002), respectively. Consequently, it could be noticed from these results that increasing of dietary protein level and decreasing stocking density may play a role in immuno response system and then enhance the ability of growing quails to face any microbial infection. Since, as a result of increasing stocking density, birds immune defenses may be decreased, leading to an increase in susceptibility to infections (Erisir and Erisir, 2002). The slightly decrease in PCV% in female quails may be attributed to the higher estrogenic effect, since estrogen administration to sexually immature quail depressed erythrocyte numbers from $3.2x10^6$ to $1.6x10^6$ in males and from $3.19x10^6$ to $1.44x10^6$ in females (Nirmalan and Robinson, 1972).

Carcass traits:

Weight of the different edible parts of quail chicks were significantly (P<0.05 or 0.01) increased with decreasing stocking density and increasing protein level except heart weight in both sexes and gizzard in males, which insignificantly increased with the decreasing stocking density (Table 6). Groups of 15 birds/m^2, which fed the higher level of protein, were accompanied by the highest weight of the different edible parts (P<0.05 or 0.01). Other results supported the present results, Lewis *et al.,* (1997) in broiler chicks and Janiszewska *et al.,* (1997) in crossbreeds of muscovy drakes with pekin ducks, mentioned that carcass quality decreased; i.e., birds was of less breast meat and of small frames. Also, the effect of stocking

Table 6. Effect of stocking density and dietary protein level and their interactions on male and female carcass characteristics of Japanese quails.

Items	Male edible parts (g)				Total	Female edible parts (g)				Total
	Carcass	Heart	Liver	Gizzard		Carcass	Heart	Liver	Gizzard	
Stocking density	*	NS	*	NS	**	*	NS	*	*	**
15 birds/m^2	125.36^{a}	2.04	4.61^{a}	3.72	135.72^{a}	139.50^{a}	2.10	7.13^{a}	4.82^{a}	153.57^{a}
20 birds/m^2	125.56^{a}	1.98	3.66^{b}	3.74	134.94^{a}	136.49^{a}	1.78	5.98^{ab}	3.99^{b}	148.23^{ab}
25 birds/m^2	114.12^{b}	1.92	2.64^{c}	3.33	122.02^{b}	115.24^{b}	1.90	4.74^{b}	4.42^{ab}	126.31
Protein level %		NS	*	NS	*	*	NS	*	*	**
21	113.59^{b}	1.64	3.37^{b}	3.31	121.91^{c}	121.59^{c}	1.67	4.92^{b}	4.38^{ab}	132.56^{c}
23	122.38^{a}	2.18	2.97^{b}	3.52	131.04^{b}	130.42^{b}	1.87	5.37^{b}	3.99^{b}	141.64^{b}
25	129.08^{a}	2.12	4.58^{a}	3.97	139.74^{a}	139.22^{a}	2.24	7.57^{a}	4.87^{a}	153.90^{a}
Interactions	**	NS	**	NS	**	**	**	**	**	**
15 birds/m^2 21%	119.23^{b}	1.63	4.13^{bc}	3.47	128.47^{c}	127.63^{bcd}	1.53^{de}	6.87^{abc}	4.10^{bcd}	140.13^{c}
23%	125.13^{ab}	2.40	3.90^{c}	3.37	134.80^{abc}	142.67^{ab}	2.40^{a}	6.87^{abc}	5.27^{a}	157.20^{ab}
25%	131.70^{ab}	2.10	5.80^{a}	4.33	143.93^{ab}	148.20^{a}	2.37^{ab}	7.67^{ab}	5.100^{ab}	163.33^{a}
20 birds/m^2 21%	121.13^{ab}	1.80	3.10^{cd}	3.60	129.63^{c}	131.00^{bc}	1.80^{bcde}	4.47^{cd}	4.23^{abcd}	141.50^{c}
23%	122.13^{ab}	2.07	2.50^{d}	3.57	130.27^{bc}	135.37^{abc}	1.47^{e}	5.17^{bcd}	3.23^{d}	145.23^{bc}
25%	133.43^{a}	2.07	5.36^{ab}	4.07	144.93^{a}	143.10^{ab}	2.07^{abcd}	8.30^{a}	4.50^{abc}	157.97^{ab}
25 birds/m^2 21%	100.40^{c}	1.50	2.87^{cd}	2.87	107.63^{d}	106.13^{e}	1.67^{de}	3.43^{d}	4.80^{ab}	116.03^{d}
23%	119.87^{b}	2.07	2.50^{d}	3.63	128.07^{c}	113.23^{de}	1.73^{cde}	4.07^{d}	3.47^{cd}	122.50^{d}
25%	122.10^{ab}	2.20	2.57^{d}	3.50	130.37^{bc}	126.37^{cd}	2.30^{abc}	6.73^{abc}	5.00^{ab}	140.40^{c}

Means in the same column within each factors differently superscripted are significantly differed ($P<0.05$ or 0.01), ns = not significant.

density on many slaughter and carcass parameters was statistically significant (Ozcelik *et al.*, 1999). While, Mizubuti *et al.* (2000) showed that the different densities did not influence carcass characteristics of broilers.

The effect of crude protein levels was in fairly agreement with the findings recorded in broilers by Hirwade *et al.*, (1995), who mentioned that average edible meat per Kg live weight was superior in groups given 20% crude protein vs. 18 or 22%. Also, Alleman *et al.*, (2000) reported that reducing crude protein content always decreased breast muscle proportion. In contrary, there is no significant differences in the same studied traits of carcass due to dietary protein level in a trial on growing quails (Abdel-Azeem *et al.*, 2001).

All the different edible parts weight of female quails were greater than those of males, except, the heart weight that recorded conflicting values in males and females. Tserveni-Gousi and Yannakopoulos, (1986) reported that carcass and breast weights of growing quails at 42 days were higher in female than those of male. Also, Torges and Wegner (1984) and Singh and Panda (1987) found that Females quails dressing percentage and percentage of breast in the carcass were surpassed those of male. Moreover, there were significant differences in carcass; liver and giblets percentages but, they were insignificant in Gizzard and heart of growing quails at 6 weeks of age (Abdel-Azeem *et al.*, 2001). They added that female recorded the highest percentages of liver; gizzard and giblets vs. male.

Conclusively, increasing stocking density up to 20 birds/m^2 and dietary protein level up to 25% had a good effect on the biological performance of quails through the early stage of growth period (up to 4 weeks). While, through the last stage of growing (4-7 weeks), decreasing the density to the lowest level (15 birds/m^2) with any level of protein (18; 20 or 22%) resulted in the best biological performance of quails.

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الأداء البيولوجي للسمان الياباني النامي تحت تأثير كثافة القطيع ومستوى بروتين العليقة

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لدراسة تأثير كثافة القطيع ومستوى بروتين العليقة على الأداء البيولوجي للسمان الياباني تم استخدام عدد مقداره ٥٤٠ كتكوت غير مجنس عمر ٧ أيام من السمان الياباني وزعت عشوائيا إلى ٣ × ٣ توزيع عاملي والذي اشتمل على ثلاث كثافات للقطيع (١٥ ، ٢٠ ، ٢٥ طائر / م٢) مع ثلاث مستويات من بروتين العليقة (٢١ ، ٢٣ ، ٢٥% بروتين خام لفترة البادئ و ١٨ ، ٢٠ ، ٢٢% بروتين خام لفترة النامي). أظهرت النتائج أن الازدحام أثر سلبيا (< ٠,٠٥ أو ٠,٠١) على صفات النمو. السمان المربى في ٢٠ طائر / م٢ ومغذى على المستوى العالي من البروتين الخام أعطى أعلى وزن جسم (١١١,٣ جرام) وأعلى معدل زيادة في الوزن (٩٣,٤ جرام) عند ٤ أسبوع & من ١ – ٤ أسبوع على التوالي إلا أنها ساءت فيما بعد. الطيور المرباة فى أقل كثافة للقطيع وغذيت على أي مستوى من البروتين أعطت أعلى صفات نمو. سجلت مجموعة الكثافة العالية (٢٥ طائر / م٢) أقل معدل لأستهلاك الغذاء من ٤–٧ أسبوع (< ٠,٠١) ومن ١–٧ أسبوع (< ٠,٠٥) بينما لم تؤثر كثافة القطيع على الكفاءة الغذائية. الطيور المغذاة على المستوى العالي للبروتين سجلت أعلى معدل لاستهلاك العليقة والكفاءة الغذائية (< ٠,٠٥) من٤–٧ أسبوع. أثر التداخل بين كثافة القطيع ومستوى البروتين بصورة معنوية (< ٠,٠٥) على الكفاءة الغذائية من ١–٤ أو ٤–٧ أسبوع حيث سجلت الطيور المرباة في ٢٠ طائر / م٢ والمغذاة على المستوى العالي أو المنخفض من البروتين أقل كفاءة غذائية من ١–٤ أو ٤–٧ أسبوع على التوالي. سجلت الطيور المرباة في ١٥ طائر /م٢ أعلى محتوى للبلازما من البروتين الكلى أو أقسامه المختلفة أو نسبة الــ A/G سواء في الذكور أو الإناث. زاد البروتين الكلى فى البلازما معنويا (< ٠,٠٥) مع زيادة بروتين العليقة في الجنسين. بلازما الدم في الإناث سجلت قيم أعلى من البروتين الكلى وأقسامه المختلفة ونسبة الــ A/G فيما عدا الجلوبيولين مقارنة بالذكور. لم يؤثر التداخل على هذه الصفات في الجنسين. الطيور المغذاة على البروتين العالي ومرباة في الكثافة العالية سجلت أعلى مستوى للكوليسترول في الجنسين ولو أن التباين في هذه الصفة نتيجة لأثر التداخل كان معنوي (< ٠,٠١) في الذكور فقط. نشاط إنزيم الــ GOT زاد أو نقص معنويا (<٠,٠١) مع زيادة كثافة القطيع أو بروتين العليقة. نشاط إنزيم الــ GOT أو الــ GPT كان أعلى قليلا أو متماثل فى الإناث مقارنة بالذكور. النسبة المئوية للمكونات الخلوية (PCV%) زادت معنويا (<٠,٠١) مع نقص أو زيادة كثافة القطيع ومستوى البروتين على التوالي في الجنسين ولو أن تأثير التداخل كان غير معنوي. قيم الــ PCV% كانت أعلى في الذكور عنها في الإناث.وزن الأجزاء المأكولة زاد معنويا (< ٠,٠١) مع نقص كثافة القطيع وزيادة مستوى البروتين فيما عدا وزن القلب في الجنسين والقانصة في الذكور. الطيور المرباة في ١٥ طائر/م٢ والمغذاة على المستوى العالي من البروتين سجلت أعلى وزن للأجزاء المأكولة (< ٠,٠٥ أو ٠,٠١). الأجزاء المأكولة في الإناث كان أعلى منها في الذكور فيما عدا وزن القلب.