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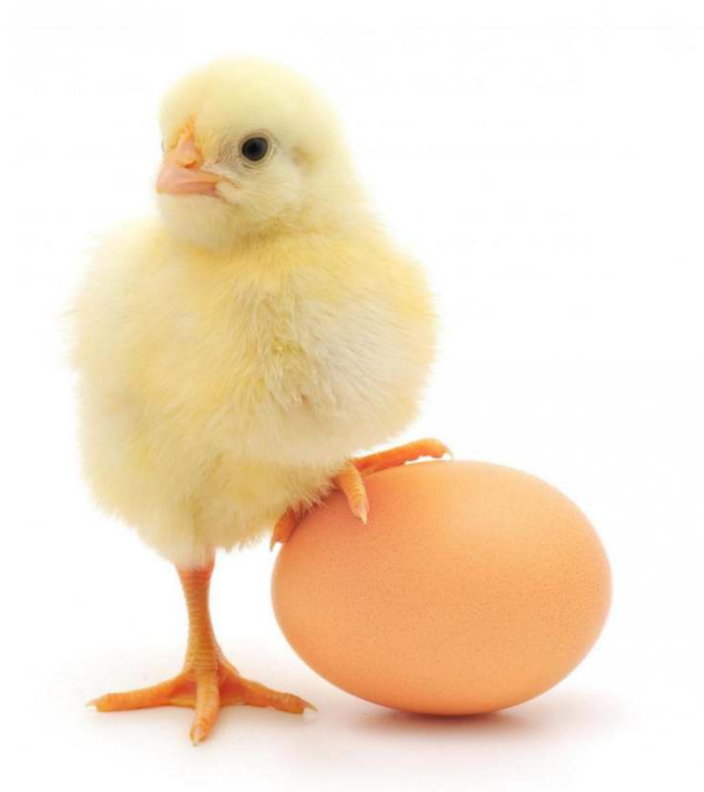

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ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

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Effect of Dietary Calcium Sources and Levels on Egg Production and Egg Shell Quality of Japanese Quail

F. Sultana[1]*, M.S. Islam and M.A.R. Howlider
Department of Poultry Science, Bangladesh Agricultural University, Mymensingh, 2202, Bangladesh

Abstract: The research was conducted at Bangladesh Agricultural University Poultry Farm, Mymensingh to evaluate the effect of different levels and sources of calcium on egg production and egg shell quality of Japanese quail (*Coturnix coturnix japonica*) up to 23 weeks of age. For that purpose a total number of 108 Japanese quails aged 20 week were fed on diets containing different levels (2.5%, 2.75% and 3.0%) of dietary calcium from different sources eg. Oyster shell, limestone and Calcium premix. They were placed in the experimental cages. Six birds were considered for a replication of each treatment. The birds were reared in clean laying cages an open sided house. The experimental quails were exposed to identical care and management throughout the experimental period. Feed and water were offered *ad libitum*. Eggs were collected twice daily at morning and evening. The number of eggs laid by birds in each replication was recorded daily. The external quality of collected eggs were measured weekly from each treatment and level randomly. No significant difference ($p>0.05$) in egg weight, shell weight, shell percentage, except egg production and shell thickness was noted due to variation of different levels and calcium sources. But as the birds were getting older calcium premix produced better shell quality than oyster shell and limestone. It was concluded that any of these calcium sources can be considered for laying Japanese quail but calcium premix produces better shell quality at later age. This result also suggested that a level of 2.5% calcium increases egg weight and shell thickness, while 2.75% increases body weight and shell weight and 3% increases egg production and shell percentage.

Key words: Quail, egg production, egg shell quality, oyster shell, limestone, calcium premix

Introduction

Egg breakage still represents a major economic loss to the poultry industry. It was estimated that 13 to 20% of total egg production was cracked or lost before reaching their final destination (Roland, 1988). So, laying hens should be given proper calcium rich feed in their diet not only for the formation of egg shell but also for the high quality of egg shell, necessary for the prevention of breakage during handling and hatching. In general, the symptoms of calcium deficiency cause thin egg shell, reduced egg production, loss of appetite, leg weakness, cage layer fatigue and osteoporosis. Feeding with mild calcium deficiency, egg production generally decreases but does not stop completely. However, sometimes hens could lay at a high rate, even though they fed on a low calcium diet. In such cases, calcium is removed from the bones resulting in hens becoming lame and crippled and sometimes death ensures (Singh and Panda, 1988).

A number of calcium sources are being used to meet up the requirement of dietary calcium for birds. Among these, oyster shell and limestone are the excellent sources of calcium and are extensively used in poultry diet (McNaughton *et al.,* 1974; Gerry, 1980; Roland, 1989). The other calcium sources are steamed animal bone meal, dicalcium phosphate, rock phosphate, calcium phosphate, marine shell, calcium carbonate, pulverized egg- shell, zeolite, aragonite, gypsum, marble chips and even portland cement (North and Bell, 1990; Angulo *et al.,* 1987).

Although problems associated with shell quality have been studied extensively in the hen, very limited information is available in quails. As in the case of hen, a deficiency of calcium in the diet of quails cause decline in egg production. The optimum level of dietary calcium for high egg production and hatchability appears to be 2.5 to 3 percent, while higher level caused reduced hatchability. Singh and Panda (1988) found among the three calcium levels of 2, 3.4 and 3.75. Only calcium level 3 showed better result in increasing egg production and egg shell quality.

Farmers have to produce quality shelled egg. To do so, they have to select good quality and cheap dietary calcium source. There are lots of calcium sources available to choice as dietary supplement to boost up shell quality but still confrontation sometimes arises that which one to be most effective. Oyster shell is harder than egg- shell, but it is well known that for egg shell formation blood Ca^{++} must be available in the uterus at night. With regard to the level of calcium, it is revealed

[1]**Corresponding Author:** F. Sultana, Apartment No-151, Tsukuba International House, 2-1-9, Kannondai, Tsukuba, Ibaraki 305-0035, Japan

that there is a gap of research with the intermediary level of 2.50 and 3. So the proposed level might be 2.5, 2.75 and 3. Thus, there is a definite controversy regarding the level of calcium for Japanese quail. Therefore, more research are needed to solve this problem. Moreover, many works have been done only viewing shell quality. Very limited works have been undertaken regarding over all egg quality and egg production of laying quail. Keeping all above facts in mind, the present study was undertaken with the following objectives:

1. To test the effect of oyster shell, limestone and calcium premix on body weight, egg production and egg shell quality of Japanese quail.
2. To find out the suitable source and the optimum level of calcium for Japanese quail.

Materials and Methods

The research was conducted for a period of 4 weeks at Bangladesh Agricultural University Poultry Farm, Mymensingh with 108 Japanese quails (*Coturnix coturnix japonica*) aged 20 weeks to evaluate the effect of different levels of oyster shell, limestone and calcium premix on egg production and egg shell quality. They were placed in the experimental cages, 6 birds were considered for a replication of each treatment. Required feed ingredients for preparing experimental diets were supplied by Bangladesh Agricultural University Poultry Farm. Oyster shell, limestone and calcium premix were purchased from the local market of Mymensingh district town. Corn, Rice polish, Soyabean meal, Full fat Soyabean, Jassoprot, Til oil cake oyster shell or limestone or calcium premix, common salt and vitamin-mineral premix were mixed according to requirements of NRC (1994). Feed ingredients in three dietary treatments were same except for three test ingredients, e.g., oyster shell, limestone and calcium premix and also Corn because, Corn was adjusted according to the different level of testing ingredients (Table 1, 2 and 3). All feed ingredients were hand mixed thoroughly and vitamin-mineral premix was mixed properly. Mixed feed was prepared weekly. The experimental diets were prepared weekly and stored in plastic containers. Feed and water were offered *adlibitum*. Eggs were collected twice daily at 9.30 am and 3.30 pm. In experimental period, the birds were exposed to 14 hours day length followed by 2 hours of artificial light in the evening by using 60-watt electric bulb hanged 2 meter above the floor. The number of eggs laid by birds in each replication was recorded daily and expressed weekly hen day egg production per cent. Eggs from each replication were collected and brought to laboratory for examination on each 7 days period. Three eggs from each replication and 27 from each treatment and level were randomly collected in each 7day period. Eggs were washed, dried and then numbered on both ends.

Clean and numbered eggs were weighed using an electric balance (Denver Instrument Co. USA). Weighed

Table 1: Composition of experimental diets

Ingredients (%)	Calcium Premix		
	3%	2.75%	2.5%
Corn	0.4215	0.4345	0.4345
Soyabean meal	0.2100	0.2100	0.2100
Full fat soyabean	0.1000	0.1000	0.1000
Rice polish	0.1000	0.1000	0.1000
Calcium premix	0.0610	0.0540	0.0480
Jessoport	0.0600	0.0600	0.0600
Til oil cake	0.0400	0.0400	0.0400
Common salt	0.0050	0.0050	0.0050
Vitamin-premix	0.0025	0.0025	0.0025
Calculated Composition			
Metabolizable energy (Kcal/kg)	2842	2852	2861
Crude protein (%)	23.09	23.02	23.20
Crude fiber (%)	4.36	4.38	4.41
Ether extract (%)	6.01	6.10	6.15
Calcium (%)	3.01	2.76	2.51
Lysine (%)	1.14	1.15	1.15
Methionine (%)	0.33	0.34	0.33
Tryptophan (%)	0.26	0.27	0.26

Table 2: Composition of experimental diets

	Oyster shell		
Ingredients (%)	3%	2.75%	2.5%
Corn	0.4185	0.4245	0.4315
Soyabean meal	0.2100	0.2100	0.2100
Full fat soyabean	0.1000	0.1000	0.1000
Rice polish	0.1000	0.1000	0.1000
Oyster shell	0.0640	0.0580	0.0510
Jessoport	0.0600	0.0600	0.0600
Til oil cake	0.0400	0.0400	0.0400
Common salt	0.0050	0.0050	0.0050
Vitamin-premix	0.0025	0.0025	0.0025
Calculated Composition			
Metabolizable energy (Kcal/kg)	2838	2858	2882
Crude protein (%)	23.32	23.38	23.44
Crude fiber (%)	4.38	4.39	4.04
Ether extract (%)	6.15	6.17	6.20
Calcium (%)	2.99	2.78	2.53
Lysine (%)	1.14	1.14	1.14
Methionine (%)	0.36	0.36	0.34
Tryptophan (%)	0.26	0.26	0.26

on all the eggs were recorded and average was calculated for each replication. The eggs were broken at the equator region by the help of spatula and the interior contents were allowed to drain out. The egg shell along with membrane was sunk in 5% EDTA solution for 30 minutes. After then shell membrane was removed carefully. Egg shells were dried in the air and weight was taken using an electric balance (Denver Instrument Co. USA). The shell percentage was calculated using the following formula

$$\text{Shell percentage} = \frac{\text{Weight of egg shell}}{\text{Egg weight}} \times 100$$

After drying, shell thickness was measured using an egg shell thickness meter (Ogawa sciki Co. Ltd. Tokyo,

Table 3: Composition of experimental diets

Ingredients (%)	Lime stone		
	3%	2.75%	2.5%
Corn	0.4165	0.4235	0.4305
Soyabean meal	0.2100	0.2100	0.2100
Full fat soyabean	0.1000	0.1000	0.1000
Rice polish	0.1000	0.1000	0.1000
Lime stone	0.0660	0.0590	0.0520
Jessoport	0.0600	0.0600	0.0600
Til oil cake	0.0400	0.0400	0.0400
Common salt	0.0050	0.0050	0.0050
Vitamin-premix	0.0025	0.0025	0.0025
Calculated Composition			
Metabolizable energy (Kcal/kg)	2831	2855	2861
Crude protein (%)	23.31	23.37	23.42
Crude fiber (%)	4.37	4.39	4.41
Ether extract (%)	6.14	6.17	6.21
Calcium (%)	2.99	2.75	2.51
Lysine (%)	1.14	1.14	1.14
Methionine (%)	0.36	0.36	0.36
Tryptophan (%)	0.26	0.26	0.26

Japan) in millimeter. To reduce error, three measurements were taken for each egg shell; one on large end, one on small end and one on the equator region. The mean of three measurements was considered as the shell thickness of a particular egg. All recorded and calculated data were for a 3 (calcium sources)×3 (levels of calcium) factorial experiment with multiple observations (2) per cell in a Completely Randomized Design (CRD). An Analysis of Variance (ANOVA) was performed to partition variances into sources, level; sources×level and error to compare different parameters among the treatments combinations. If ANOVA showed significant difference, Least Significant Difference (LSD) was calculated to isolate the differences test at 1 and 5% level provability (Gomez and Gomez, 1984).

Results and Discussion

The data obtained during the experimental period for different parameters were analyzed and the results were presented in Table 4 and 5. The results are stated under the following subheadings to evaluate the effects of different dietary calcium sources.

Effect of different dietary calcium sources and different levels on body weight and egg production: The data presented in Table 4 showed that calcium source, their level and their interaction did not influence (P>0.05) initial live weight, final live weight, average egg production at 20th, 21st and 23rd week of experimental period. However, calcium level significantly influenced (P>0.05) egg production at 22nd week of age. Where egg production was the highest on 2.75% dietary calcium, intermediate on 3% while it was lowest on 2.5% dietary calcium. Calcium source and its interaction with calcium level had little effect (P>0.05) on egg production at 3rd week of the experiment.

Body weight: Initial and final body weight of quail was presented in Table 4. Data showed that average body weight of quails were statistically similar and average 145.83 g/quail during the initial stage of trial. At the end of the experiment result showed that body weight non-significant (P>0.05) increased for every treatment irrespective of different levels of supply. However, data showed that 2.75% level of supplementation of calcium irrespective of different sources result showed non-significantly (P>0.05) higher body weight gain than the other two levels. In final weight gain, there is no significant (P>0.05) effect of the interaction of different source and levels. Cheng and Coon (1990), supplied dietary calcium from various sources and found no significant different in body weight and egg production. Oliveira *et al.* (1997), supplied dietary calcium from different sources and found no significant different in egg production and body weight.

Egg production: Hen day egg production per cent of the three treatments differ significantly P<0.05 (Table 4). However, average hen day egg production was 58.83% for Oyster shell, 59.72% for limestone and 63.19% for calcium premix. The result also indicate that there is no significant (P>0.05) effect of different levels of calcium irrespective of calcium sources on hen day egg production per day. The similarity of egg production per cent revealed that different dietary calcium level had no effect on hen day egg production. This result is in agreement with some previous research findings. Scheideler (1998), Makled and Charles (1987) observed that egg production did not significantly (P<0.05) differ due to various calcium sources. Florescu *et al.* (1986) supplied dietary calcium form various sources and found no significant different in egg production. However, there is no significant (P>0.05) effect of interaction of different calcium sources and levels on hen day egg production per cent.

Final body weight and egg production: Considering the effect of different sources and levels of calcium results indicated that the highest final body weight (162.50g) was found with the birds were fed on diet containing 2.75% lime stone, though the result was not significant. The percentages of average egg production of birds at 21st week of age supplied with the diet containing 2.5% of calcium premix was found highest (71.43) followed by 67.86% with the diet containing 3% lime stone. Similar trend was also observed with different levels of calcium sources supplied to the birds at 22nd weeks of age. But it was significantly highest (64.29%) with the diet containing 2.75% calcium premix. At the age of 24th week the average percentage of egg production was found, highest (70.24%) with the diet containing 3% calcium premix followed by 3% oyster shell (65.48%), but their differences were not significant. Considering the effect of mean values of different levels of calcium premix,

Table 4: Interaction of calcium sources and their dietary levels on body weight and egg production performance of quail with different treatments

Variables	Source of calcium (SC)	Level of dietary calcium (%) (LC) 3%	2.75%	2.50%	Mean	(SED)/LSD and siginificance SC	LC	SCXLC
Initial body weight/bird (g)	Ca-premix	146	137.5	146	143.2	5.717 NS	5.717NS	9.902 NS
	Oyster shell	146	145.5	150	147.2			
	Lime stone	141.5	158.5	141.5	147.2			
	Mean	144.5	147.2	145.8	145.8			
Final body weight/bird (g)	Ca-premix	154	150	146	150	3.813 NS	3.1813 NS	6.604 NS
	Oyster shell	150	150	150	150			
	Lime stone	154	162.5	150	155.5			
	Mean	152.7	154.2	148.7	151.8			
Average egg production at 1st week (%)	Ca-premix	61.92	66.67	71.43	66.67	3.802 NS	3.820NS	6.617 NS
	Oyster shell	60.72	69.05	63.1	64.29			
	Lime stone	67.86	59.52	64.29	63.89			
	Mean	63.49	65.08	66.27	64.95			
Average egg production at 2nd week (%)	Ca-premix	59.52	59.53	58.33	59.13	1.9628 NS	1.9618 NS	3.398 NS
	Oyster shell	56.45	54.76	53.38	54.86			
	Lime stone	58.33	59.52	59.52	59.12			
	Mean	58.10	57.94	57.07	57.7			
Average egg production at 3rd week (%)	Ca-premix	63.1	64.29	59.52	62.3	1.870 NS	1.870*	3.239 NS
	Oyster shell	59.52	57.64	53.38	56.85			
	Lime stone	55.95	57.14	55.26	56.12			
	Mean	59.52	59.69	56.05	58.42			
Average egg production at 4th week (%)	Ca-premix	70.24	61.91	61.91	64.68	3.305 NS	3.305 NS	5.725 NS
	Oyster shell	65.48	61.9	53.52	60.32			
	Lime stone	60.72	61.9	57.15	59.92			
	Mean	65.48	61.9	57.54	61.64			
Average egg production (%)	Ca-premix	63.69	63.1	62.8	63.19	1.426 NS	1.426*	2.470NS
	Oyster shell	60.42	60.72	55.36	58.83			
	Lime stone	60.72	59.53	58.93	59.72			
	Mean	61.61	61.11	59.03	60.58			

NS= Non significant (P>0.05) * = significant at 5% level (P<0.05)

Table 5: Interaction of calcium sources and their dietary levels on egg weight and egg quality of quail with different treatments

Variables	Source of calcium (SC)	Level of dietary calcium (%) (LC) 3%	2.75%	2.5%	Mean	(SED) / LSD and significance SC	LC	SCXLC
Average egg weight (g)	Ca-premix	10.63	10.34	10.30	10.42	0.321 NS	0.321NS	0.556 NS
	Oyster shell	9.23	9.64	9.72	9.53			
	Lime stone	9.37	10.50	10.70	10.19			
	Mean	9.74	10.16	10.24	10.05			
Average shel weight (g)	lCa-premix	0.80	0.80	0.80	0.80	0.027 NS	0.027 NS	0.048 NS
	Oyster shell	0.77	0.75	0.72	0.74			
	Lime stone	0.75	0.84	0.80	0.84			
	Mean	0.77	0.80	0.77	0.78			
Average shell thickness (mm)	Ca-premix	0.21	0.21	0.22	0.21	0.004 NS	0.004*	0.008 NS
	Oyster shell	0.22	0.22	0.22	0.22			
	Lime stone	0.23	0.23	0.23	0.23			
	Mean	0.22	0.22	0.23	0.22			
Average shell weight (%)	Ca-premix	7.59	7.78	7.80	7.72	0.327 NS	0.327 NS	0.566 NS
	Oyster shell	8.23	7.81	7.37	7.83			
	Lime stone	8.00	8.00	7.50	7.83			
	Mean	7.97	7.86	7.56	7.80			

NS= Non significant (P>0.05) * = significant at 5% level (P<0.05)

oyster shell and lime stone on average egg production was also found significantly highest with the diet containing 3% calcium premix (63.19%) followed by lime stone.

Effect of different dietary calcium sources and different levels on egg weight and egg shell quality: The data presented in Table 5 show that calcium source, their level and their interaction did not significantly (p>0.05) influence egg weight, shell weight and shell per cent but dietary calcium source had significant effect (p<0.05) on shell thickness. Shell thickness was highest on 2.5% dietary calcium, while it is intermediate and lowest on 2.75% and 3% dietary calcium, respectively. However, change in shell thickness could not be explained (P>0.05) by the variation of calcium source and its interaction with calcium level.

Egg weight: Egg weight on different treatments Table 5 did not differ significantly (P>0.05). Egg weights of different treatment irrespective of different levels were 9.53g for oyster shell, 10.19g for limestone and 10.42g for calcium premix. Egg weights on different levels of calcium irrespective of different sources of calcium were 9.74g for 3%, 10.16g for 2.75% and 10.24g for 2.5%. Lack of influence on dietary calcium sources on egg weight obtained in current finding is in agreement with some researchers. Richter *et al.* (1999) used dietary calcium from various source and found no significant difference in egg weight. Scheideler (1998) and Rabon *et al.* (1991) also observed that egg weight did not significantly differ due to various calcium sources. However, there was no significant (P>0.05) difference found on average egg weight by the interaction of different calcium source and their different levels.

Egg shell weight: Egg shell weight did not differ significantly (P>0.05) due to different sources of calcium (Table5). Egg shell weights of different treatments irrespective of different levels were 0.74g for oyster shell, 0.80g for limestone and 0.80g for calcium premix. Egg shell weights of different levels of calcium irrespective different sources were 0.77g for 3%, 0.80g for 2.75% and 0.77g for 2.5%. The similar of shell weight was due to lack of influence of various calcium sources on shell weight. Richter *et al.* (1999) used calcium from various sources and found no significant difference in shell weight. Anderson *et al.* (1982), Cheng and Coon (1971) observed no significant difference on shell quality when they substitute limestone by oyster shell.
However, there was no significant (P>0.05) difference found on average egg weight by the interaction of different calcium source and their different levels. The increasing of shell weight suggests that calcium premix helped to maintain shell weight as the birds were getting older.

Egg shell percentage: Egg shell percentages of different treatments irrespective of different level were 7.83% for oyster shell, 7.83% for limestone and 7.72% for calcium premix (Table 5). Moreover shell percentages of different levels irrespective of different source of calcium were 7.97% for 3.0%, 7.86% for 2.75% and 7.56% for 2.5%. The results did not differ significantly (P>0.05). As birds were fed on different sources of dietary calcium, no differences were observed on shell percentage between dietary calcium sources. The results are partially consistent with Cheng and Coon (1990); they replaced limestone by oyster shell in layer diet. Anderson (1982) also observed that different calcium sources gave equivalent shell percentage. However, there was no significant (P>0.05) difference found on average egg weight by the interaction of different calcium source and their different levels. This result suggests that calcium premix improved shell percentage at older age of bird.

Egg shell thickness: Egg shell thickness of different treatments differ significantly (P>0.05) (Table 5). Egg shell thickness of different sources irrespective of level was 0.22 mm for oyster shell, 0.23 mm for limestone and 0.21 mm for calcium premix. However, shell thickness of different levels irrespective of treatments did not differ significantly (P>0.05) was 0.22 mm for 3.0%, 0.22 mm for 2.75 and 0.22 mm for 2.5%. As all birds were treated with similar management; so this result revealed that different dietary sources of calcium have no significant effect on egg shell thickness. Florescu *et al.* (1986) supplied dietary calcium from various sources and found no significant difference among the treatments in shell thickness. These results coincided with the findings of Cheng and Coon (1990). They observed no significant difference on shell thickness when they replaced limestone by oyster shell.
However, there was no significant (P>0.05) difference found on average egg weight by the interaction of different calcium source and their different levels. This result suggests that calcium premix improved shell thickness as the birds were getting older.
The recorded results (Table 4 and 5) indicate that lack of experience of calcium source and its interaction with calcium level on egg weight and shell thickness at all ages except at 2nd and 3rd week of age. The data signify that egg production at 3rd week of experimental period was maximum on 2.75% calcium level. While shell thickness was maximized at calcium level of 2.5%.
Considering the above result it may be concluded that the increasing of shell weight suggests that calcium premix helped to increase shell weight as the birds were getting older. This result also suggests that calcium premix improved shell percentage as well as shell thickness at older age of bird. There were no significant differences on shell thickness when limestone replaced by oyster shell. This result also suggested that a level of 2.5% calcium increases egg weight and shell thickness, while 2.75% increases body weight and shell weight and 3% increases egg production and shell percentage.

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