J. Sylhet Agril. Univ. 5(2):113 - 119, 2018 **ISSN: 2308-1597**

EFFECT OF ORGANIC SELENIUM SUPPLEMENTATION ON PRODUCTIVE AND REPRODUCTIVE PERFORMANCES OF JAPANESE QUAIL

MM Khan, MN Hossain*, MA Baset and MN Uddin

Department of Livestock Production and Management
Sylhet Agricultural University, Sylhet, Bangladesh

(Available online at www.jsau.com.bd)

Abstract

The aim of this study was to evaluate the effect of dietary organic selenium (Se) supplementation on productive and reproductive performances (egg production, body weight, egg quality and hatchability) of the Japanese Quail. A total of 72 Japanese Quails of 10 weeks age (60 laying females and 12 adult males) were randomly and equally allocated to 4 Dietary groups each with 3 replicates of 5 females and 1 male (n=18). Four dietary groups T_0, T_1, T_2 and T_3 were formulated by adding 0.0, 0.25, 2.5 and 25 ppm Se with the maize based basal diets. Results demonstrated that the hen day egg production reduced ($p<0.05$) at T_3 group without altering the feed intake, body weight and survivability of the birds. Albumen index, Yolk index and Haugh unit were found to be higher ($p<0.05$) in the eggs of T_1 and T_3 bird groups. The fertility and hatchability were also higher ($p<0.05$) on T_1 and T_2 bird groups in compared that of T_0 and T_3 bird groups. Embryonic mortality were found to be significantly lower ($p<0.05$) on T_1 and T_2 groups during the whole incubation period. The weight of ovary, oviduct and number of ovarian follicles did not differ among the treatment groups, but damaged liver and cystic ovarian follicles were observed at T_3 group. The present study reveals that dietary supplementation of 0.25 ppm organic Se has positive effect on the productive and reproductive performances of Japanese quail.

***Keywords*: Organic Selenium, Productive, Reproductive, Performance, Japanese Quail.

Introduction

Selenium (Se) is an essential micro mineral involved in many important physiological functions like reproduction, immunity, growth and development of farm animal including poultry (Surai & Dvorska, 2002). The crucial role of Se in body's antioxidant defense system as a constituent part of glutathione peroxidase (GSH-Px), thioredoxin reductase and methionine sulphoxide reductase B has received considerable attention in last few years. Efficiency of vitamin E also increases in chicks fed with Se diet. Exudative diathesis develop in poultry due to deficiency of Vitamin E in the diet but Se can prevent the development of it. Se even in the absence of vitamin E prevented the development of exudative diathesis in poultry (Sing and Panda, 1988).

Supplementation of Se in livestock diet is a common and already proven as effective practice (Bourne *et al.* 2008). Both organic Se (Seleno-methionine) and inorganic Se (selenite or selenite) are added to poultry diets. Data accumulated over the last decade between two forms of Se, organic form Seleno-methionine (Se-Met) provides more Se reserves in the body and efficiently transferred into the egg, colostrums and milk (Surai & Dvorska, 2002). An important application of organic Se is related to its potentiality to protect developing avian embryo from peroxidation during embryogenesis and hatching (Surai, 2000; Paton *et al.*, 2002). Se transferred from hatching egg to embryo and affects antioxidant defense during hatching and postnatal life of chick (Surai, 2002). Se availability is a key for effective GSH-Px synthesis in the body and transfer of Se from mother to egg effectively triggered postnatal development in bird. Organic Se has also positive effect on egg freshness and eggshell thickness (Kralik *et al.*, 2009). On the other hand, Se toxicity (Selenosis) caused by high concentration of Se in bird's food chain from plants, invertebrates and fishes (Ohlendorf *et al.*, 1998). Supplementation of Se upto 0.3 ppm is allowed in developed country with feed and Se enriched yeast are allowed to be used with feed by FDA (Chen *et al.*, 2014).

Countries or areas where Se concentration is lower in soil, plant cannot absorb proper amount of Se from the soil and natural feedstuffs, cereal grains like maize, rice, wheat and soybean contain lower amount of Se. As a consequence, farmer supply the commercial form of organic Se with natural feedstuffs to fulfill the birds requirements. But still today, very few information is available about the optimum level of Se in Japanese laying quail. Farmers are using the Sel-plex or other organic form of Se in poultry diets, particularly in diet on imagination which misleads them to use

***Corresponding author: MN Hossain,** *Department of Livestock Production and Management, Faculty of Veterinary, Animal and Biomedical Sciences, Sylhet Agricultural University, Sylhet-3100 Email: nazmul.lpm@sau.ac.bd*

over doses, resulting poor performance of the birds and economic loss. By considering this fact the experiment was conducted to investigate the effects of organic Se supplementation on egg production and egg quality, hatching performance like fertility, hatchability, embryonic death and chick weight and body weight maintenance and survivability in quail and to identify the optimum level of organic Selenium supplementation for maximum performance of quail.

Materials and Methods

Location of experiment

The experiment was carried out at Dakshin Sunamganj upazila, Sunamganj a north eastern district of Bangladesh located between 24°49’ and 25°10’ North latitudes and in between 91°14’ and 91°27’ east longitudes. It is located in tropical monsoon area with the average annual temperature is 25.0 °C and average rainfall is 3365 mm.

Experimental birds

A total of 72 Japanese Quail of 10 weeks age; 60 laying females and 12 adult males) were equally divided and randomly allocated to 4 dietary groups each with 3 replicates of 6 quail (n=18) and fed until the age of 18 weeks.

Experimental diets and dietary treatment

Birds were fed corn-soya based basal diet prepared by following NRC (1994) (Table 1) according to their age and Se was supplemented with the basal diet in 4 experimental groups like the followings:

1. T_0: Corn-soya based basal diet+ no Se supplementation
2. T_1: Corn-soya based basal diet + 0.25 ppm Se supplementation
3. T_2: Corn-soya based basal diet + 2.5 ppm Se supplementation
4. T_3: Corn-soya based basal diet + 25.0 ppm Se supplementation

Table 1. Composition of the basal feed supplied to the experimental quail

Component	Level
Moisture (maximum %)	12
Metabolizable energy (Kcal/kg)	2700
Crude protein (minimum %)	17
Crude fiber (maximum %)	5
Calcium (minimum %)	3.5
Available phosphorus (minimum %)	0.4
Lysine (minimum %)	0.8
Methionine (minimum %)	0.4

Feeding and management

The birds were housed in mosquito-net made small pens on littered floor. Birds under different treatment were marked by different color on feathers; lighting was maintained on a schedule of 16:8 hour light and dark by central 100 watt electric bulb at 1.5 m height for 4 pens. The house was well ventilated and protected from all sorts of predator and rodents. The feed was supplied 3 times daily. Safe and cool drinking water was provided to the birds at all times in chick drinker (7 bird in each drinker).

Evaluation of productive and reproductive parameters

Feed intake

The amount of feed consumed by experimental birds was calculated weekly. Similar amount of feed was given to all replications at the beginning of a week and the residue was recorded at the end of the week, then the actual amount of intake was calculated by subtracting the residue from to given amount.

Egg production and egg weight

The number of eggs laid daily were recorded and marked by marker pen after collection from the pen. The fresh eggs were weighed everyday immediately after collection by an electric egg weighing balance (Setra, German).

Egg quality

Ten eggs from each group were collected at 4^{th}, 6^{th} weeks of the experimental period for egg quality determination. The egg quality was measured for egg weight, yolk weight, Haugh unit (HU), shell thickness, shell weight, shell membrane weight, yolk color score, yolk index and albumen index. Egg weight was measured by an electric balance. The measurements from 3 different positions and the mean of these 3 measurements were considered as the average width or length of a particular egg.

The height and diameter of the albumen were measured by a micrometer and slide calipers, respectively. The average was used to calculate the albumin index as

$$\text{Albumin index} = \frac{\text{The average height of albumen}}{\text{The average width of ablumen}}$$

Haugh unit (HU) were measured by using the albumen height with the following formula (Mobaraki and Shahryar, 2015):

$HU = 100Log\ (H+7.57-1.7W^{0.37})$

Where,
H= observed height of the albumen in mm
W= weight of egg (g)

The yolk index was determined by measuring the yolk height and yolk diameter prior to removing the yolk from albumin by using the follow formula:

$$\text{Yolk index} = \frac{\text{The average height of yolk}}{\text{The average width of yolk}}$$

Egg shells were kept under running water to wash. After drying 48 hours in environmental temperature weight were taken by digital balance and average eggshell thickness were determined by measuring the eggshell in equatorial region at 3 points by a digital micrometer.

Hatching performance:

A total of 70 eggs from each treatment group were collected and were incubated for 17 days maintaining a constant 38.5 & 37°C temperature and 65 & 85% relative humidity were maintained during setter and hatcher periods, respectively. The weight of the hatched-out quail chicks was recorded by an electric balance (Setra, M-EL-410s, USA). The percentage of fertility and hatchability was calculated on the basis of total eggs set in the incubator.

$$\text{Fertilitly } (\%) = \frac{\text{No. of fertile eggs}}{\text{Total no. of eggs set}} \times 100$$

$$\text{Hatchabitiy } (\%) = \frac{\text{No. of chicks hatched out}}{\text{Total no. of eggs set}} \times 100$$

The chick weight was expressed as the percentage (%) of egg weight. The total embryonic death was expressed as the percentage (%) of fertile eggs whereas the incubation period wise death was the percentage (%) of total death during the whole incubation period.

Observation of reproductive system and other vital organ

At the end of experiment, 3 females from each dietary group were randomly chosen for dissection. The birds were dissected according to the procedure of Jones (1984) to observe the weight and deformities (if any) in the oviduct, ovary, liver, gizzard and heart.

Statistical analysis

Data were analyzed using ANOVA in General Linear Model of Minitab 17.0 versions by following a Completely Randomized Design (CRD). Average values were compared within the group by Tukey’s pairwise comparison test. Significant differences between the means of different parameters were compared by using Tukey’s test at $p<0.05$.

Results and Discussion

Egg production, feed intake and body weight gain

Effect of Se supplementation on hen-day egg production, feed intake and weekly body weight of the quail has shown in Table 2. Hen-day egg production was significantly ($p<0.05$) affected by selenium treatment. Egg production was highest in the T_1 (65.50%) group but was markedly lowest in the T_3 (45.60%) group.

Table 2. Egg production, feed intake and body maintenance of Japanese quail fed on organic Se supplemented diet

Parameters	Treatments				SEM	Level of Significance
	T_0	T_1	T_2	T_3		
Hen-day egg production (%)	63.30^{bc}	65.50^{c}	61.90^{b}	45.60^{a}	13.332	*
Feed intake (% to body weight)	15.11	14.35	15.14	14.44	0.501	NS
Weekly average body weight (g/ bird)	166.56	169.00	166.33	166.44	1.822	NS

Where, NS=not significant ($p>0.05$);* ($p<0.05$)

However, among the eggs about 2.3% and 0.8% were found to be abnormal in respect to size and eggshell thickness in the T_2 and T_3 respectively. Chantiratikul *et al. (2008)* did not found any positive impact on egg production with Selenium supplementation in laying hen. But Mobaraki and Shahryar (2015) found significant increase in egg production of Japanese Quails by Selenium and Vitamin E supplementation which does not go parallel with this study. Adebiyi *et al.* (2014) reported a significant increase in egg production of turkey supplemented with Se (0.3mg/kg feed) but the effect of Se supplementation on feed intake and weekly average body weight in this experiment was not significant. Mobaraki and Shahryar (2015) did not get any significant impact of selenium supplementation on feed intake. Mohiti-Asli *et al.* (2008) also got a parallel effect with this experiment in case of feed conversion ratio. Cruz and Fernandez (2011) reported a significant increase of feed intake and daily egg production after Selenium supplementation but Naylor *et al.* (2004) found negative impact of Selenium supplementation on feed intake and weight gain.

Egg quality

Results of Se supplementation on the egg quality of quail have been illustrated in Table 3. The albumen index, yolk index, HU and yolk color score differed significantly among the control and treatment. But the other traits, egg weight, yolk weight, eggshell weight, shell membrane weight and yolk color score did not differ significantly among the treatment groups. Albumen index, yolk index, Haugh unit and yolk color score were highest in T_1 and lowest in T_3 group. The highest egg albumen, yolk index and Haugh unit were observed in T_3 group and lowest in T_0 control group. Egg weight, yolk weight, eggshell weight and shell membrane weight did not differ significantly among the control and treatment groups.

Table 3. Egg quality of Japanese quail fed on diet supplemented with organic Se

Parameter	Treatments				SEM	Level of Significance
	T_0	T_1	T_2	T_3		
Egg weight (g)	10.84	10.79	10.93	11.22	0.43	NS
Yolk weight (% to egg weight)	37.17	35.50	36.59	41.78	2.8	NS
Eggshell (% to egg weight)	6.83	6.69	7.34	6.55	0.65	NS
Shell membrane weight (% to egg weight)	3.35	3.26	3.22	3.08	0.0	NS
Shell thickness (mm)	0.20	0.21	0.21	0.20	0.01	NS
Yolk index	0.29^{a}	0.38^{c}	0.30^{ab}	0.41^{cd}	0.08	*
Albumen index	0.05^{a}	0.07^{b}	0.05^{a}	0.08^{c}	0.02	*
Haugh unit (HU)	76.91^{a}	81.58^{c}	77.15^{ab}	85.27^{d}	4.12	*
Yolk color score	4.30	3.70	4.00	4.002	(0.58)	NS

Where, *($p<0.05$), **($p<0.0$) and NS=not significant ($p>0.05$)

The result of this study on egg weight, yolk weight, egg shell weight and albumen index are similar to the report of Mobaraki & Shahryar, (2015) who reported Se with Vitamin E supplementation do not affect the egg weight, yolk weight and shell weight but increase the albumen weight significantly ($p<0.05$) in Japanese quail. Golubkina & Papazyna (2006) also got higher albumen index after Selenium supplemented group but egg yolk and egg shell weight was lower. Lukaszewich *et al.* (2007) found a significant increase of egg yolk weight, yolk and shell percentages in Japanese quail and the effect was adverse on egg weight and yolk weight. This study also similar to the findings of Malek Mohammadi *et al.* (2009), who reported no significant effect of Se on egg weight in hen.

Hatching performance

The rate of fertility, hatchability, embryonic mortality and day-old chick weights are mentioned in Table 4. Data implies that the rates of fertility and hatchability were significantly ($p<0.05$) affected by Selenium supplementation and was higher in T_1 and T_2 bird groups. On the other hand, the rate of mortality in developing embryos differed significantly ($p<0.05$), was lowest in the T_1 group (22.40%), but gradually increased with the increase of Se supplementation level and was highest (52.80%) in T_3 group during the whole incubation period. The excessive embryonic death at T_3 group strongly support the carry over-mediated toxicity of Se in the developing embryo (Ohlendorf *et al.,* 1988). The favorable effects of maternal Se supplementation on embryonic development and post hatch growth was reported by Surai (2000) contradicted present findings that might be for difference in species of bird and doses of Se used. The day-old chick weight did not differ among all treatment groups irrespective of doses. Mobaraki and Shahryar (2015) also reported a significant increase in hatchability with different level of selenium supplementation in breeding Japanese quails after 7 and 10 days of storage which goes parallel with this experiment. Also the favorable effects of organic Se supplementation on the reproduction were agreed by Sotnikov and Trifonov (2003); Hoffman and Heinz (1998).

Table 4. Hatching performance in organic Se supplemented laying Japanese quail

Parameters	Treatments				SEM	Level of significance
	T_0	T_1	T_2	T_3		
Fertility (%)	54.70^{a}	80.80^{d}	77.50^{c}	55.60^{ab}	22.49	**
Hatchability (%)	27.30^{a}	62.50^{d}	56.5^{c}	29.30^{ab}	20.66	*
Chick weight (% to egg weight)	61.00^{c}	61.65^{cd}	59.38^{ab}	58.33^{a}	3.91	*
Embryonic mortality (%)	50.00	22.40	27.40	52.80	21.08	NS

Where, *($p<0.05$), **($p<0.01$) and NS=not significant ($p>0.05$)

Reproductive system and other vital organs

The weights of liver, heart, gizzard, ovary and oviduct along with the number of yellow ovarian follicles have been shown in Table 5. The weight of ovary, oviduct and the number of ovarian follicles in Se supplemented layer quail did not differ significantly in T_3 birds compared to control and other two Se supplemented groups. Se supplementation had no remarkable effects on liver, gizzard and heart weight of the laying birds. Ševčíková *et al.* (2006) reported non-significant effect of on liver tissue of broiler chicken supplemented with different level of selenium. However, the damaged liver along with cystic ovarian follicles was found in the T_3 group. The dietary supplementation of Se in female exerts its effects on reproduction either being transmitted into the eggs or by altering the reproductive functions. The deformed ovarian follicles and liver along with higher albumen index, yolk index and Haugh Unit at T_3 in spite of unchanged feed intake, body weight and survivability in the birds indicated that these effects was mostly oriented to the axis of reproduction than the growth and body maintenance of laying quails, the nearly similar effect of reproduction, growth and body maintenance were also reported by NRC (2005) due to excess Se feeding in birds except the mortality.

Table 5. Reproductive and other vital organs weight and the number of yellow ovarian follicles in Se supplemented laying quail

Parameter	Treatments				SEM	Level of significance
	T_0	T_1	T_2	T_3		
Oviduct weight (% to body weight)	3.07	4.40	2.72	3.23	0.86	NS
Ovary weight (% to body weight)	0.50	0.55	0.48	0.52	0.14	NS
Number of yellow follicles	3.50	3.00	2.50	4.00	1.32	NS
Liver weight (% to body weight)	2.82	2.98	3.58	3.20	0.58	NS
Gizzard weight (% to body weight)	2.84	3.46	3.14	2.59	0.01	NS
Heart weight (% to body weight)	0.72	0.82	0.74	0.76	0.06	NS

Where, NS=not significant (p>0.05)

The report of this study about the weight of ovary and oviduct are similar to the study of Attia *et al.* (2010) who did not reported any change in weight of ovary and oviduct with Se supplementation.

The conclusion can be made on the basis of present experiment is that 0.25 ppm Se supplementation with basal feed increase the weight gain, egg production, fertility, hatchability without any significant change in the reproductive and other vital internal organ of Japanese Quail.

References

Adebiyi OA, Oludare OF, Majekodunmi B and Adeniji AA. 2014. Effect of Vitamin E or selenium on blood profile and oxidative stability of turkey meat. Journal of Animal Production Advances. 4(7): 469-475.

Attia YA, Abdalah A A, Zeweil HS, Bovera F, El-Din AT and Araft MA. 2010. Effect of inorganic or organic selenium supplementation on productive performance, egg quality and some physiological traits of dual-purpose breeding hens. Czech Journal of Animal Sciences. 55(11): 505-19.

Bourne N, Wathes DC, Lawrence KE, McGowan M and Laven RA. 2008. The effect of parenteral supplementation of vitamin E with selenium on the health and productivity of dairy cattle in the UK. The Veterinary. Journal. 177(3): 381-387.

Chen G, Wu J and Li C. 2014. Effect of different selenium sources on production performance and biochemical parameters of broilers. Journal of Animal Physiology and Animal Nutrition. 98(4): 747-754.

Chantiratikul A, Chinrasri O and Chantiratikul P. 2008. Effect of sodium selenite and Zinc-L-selenomethionine on performance and selenium concentrations in eggs of laying hens. Asian-Australian Journal of Animal Sciences. 21(7): 1048-1052

Cruz VC and Fernandez IB. 2011. Effect of organic selenium and zinc on the performance and egg quality of Japanese quails. Reista Brasileira de Ciencia. Avicola. 13(2): 91-95.

Golubkina NA and Papazyan TT. 2006. Selenium distribution in eggs of avian species. Comparative Biochemistry and Physiology B Biochemistry and Molecular Biology. 145(3):384-388.

Hoffman DJ and Heinz GH. 1988. Embryotoxic and teratogenic effect of selenium in the diet of mallards. Journal of Toxicology and Environmental Health. 24: 477-490.

Jones R. 1984. A standard method of dissection for carcass analysis of poultry. Ayr, Scotlands: West of Scotland Agricultural Research. Technical Note No.: 222p.

Kralik G, Gajčević Z, Suchý P, Straková E and Hanžek D. 2009. Effects of dietary selenium source and storage on internal quality of eggs. Acta Veterinaria Brno. 78(2): 219-222.

Łukaszewicz E, Kowalczyk A, Korzeniowska M and Jerysz A. 2007. The effect of feed supplementation with organic selenium and vitamin E on physical characteristics of Japanese quail (Coturnix japonica) eggs. Polish Journal of Food and Nutrition Sciences. 57(4): 377-381.

Malek MH, Shariatmadari F, Hosseini S, Karimi, Torshizi MA, Kheirkhah A and Mohiti Asli M. 2009. The effect of different levels of vitamin E and the mineral selenium and fatty acids on egg quality in hens fed flax seed. In Proc. 3 Cong. Anim. Sci., Ferdowsi University of Mashhad, Mashhad, Iran. Pp. 44.

Mobaraki MA, Shahryar HA. 2015. The Impact of Different Levels of Vitamin E and Selenium on the Performance, Quality and the Hatchability of Eggs from Breeding Japanese Quails. Iranian Journal of Applied Animal Sciences. 5(4): 927-932.

Mohiti AM., Shariatmadari F, Lotfollahian H and Mazuji MT. 2008. Effects of supplementing layer hen diets with selenium and vitamin E on egg quality, lipid oxidation and fatty acids composition during storage. Canadian Journal of Animal Sciiences. 88: 475-483.

Naylor AJ, Choctand M and Reinke N. 2004. Selenium supplementation affects broiler growth performance, meat yield and feather coverage. British Poultry Science. 45: 677-683.

NRC (National Research Council). 2005. Selenium: Essentiality, Mineral Tolerance of Animals, National Academy Press, Washington D.C. 321-322p.

NRC (National Research Council). 1994. Nutrient requirements of ring-necked pheasants, Japanese quail and Bobwhite quail. Page 45 in Nutrient requirements of poultry; 9th edn; National Academy Sciences, Washington D.C.

Ohlendorf HM, Kilness AW, Simmons JL, Stroud RK., Hoffman DJ and Moore JF. 1988. Selenium toxicosis in wild aquatic birds. Journal of Toxicolology and Environmental Health. 24, 67-92.

Paton ND, Cantor AH, Pescatore AJ, Ford MJ and Smith CA. 2002. The effect of dietary selenium source and level on the uptake of selenium by developing chick embryos. Poultry Science. 81(10): 1548-1554.

Singh KS and Panda B. 1988. Poultry Nutrition. 1st Ed., Kalyani Publishers, New Delhi, India. 282-293p.

Sotnikov D and Trifonov G. 2003. Comparative efficiency of DAPS-25 and sodium selenite for rearing young broilers. Zhivotnovl din Naukin. 40(3): 97-99.

Surai PF. 2000. Effect of selenium and vitamin E content of the maternal die on the antioxidant system of the yolk and the developing chick, British Poultry Science. 41: 235-243.

Surai PF. 2002. Natural Antioxidants in Avian Nutrition and Reproduction, Nottingham University Press, Nottingham.65p.

Surai PF, and Dvorska JE. 2002. Effect of selenium and vitamin E on lipid peroxidation in thigh muscle tissue of broiler liens during storage. Biolological Trace Element Research. 128(2): 184-190.

Ševčíková S, Skřivan M, Dlouhá G and Koucký M. 2006. The eff ect of selenium source on the performance and meat quality of broiler chickens. Czech Journal of Animal Science. 51: 449–457.