Journal of Animal and Veterinary Advances 7 (8): 963-967, 2008
ISSN: 1680-5593

Effects of Closed Breeding on Some Reproductive Performance of a Small Japanese Quail Flock in Sanliurfa

[1]M. Yerturk, [2]M. Avci and [3]F. Bozkaya
[1]Department of Animal Science, [2]Department of Animal Nutrition,
[3]Department of Genetics, Faculty of Veterinary Medicine,
Harran University, 63300 Sanliurfa, Turkey

Abstract: The objective of this study was to evaluate the effects of closed breeding on some reproductive performance of a small commercial Japanese quail flock which had been closed bred for ten years. Seventy two laying female birds at 3 months of age were obtained from the commercial flock and randomly separated into 2 groups (closed and crossbreeding). Closed group was mated with their own male, crossbreeding group mated with males that bringing from different flock to form the first generation animal material and then each group mated with their own male to form second generation animal material in a ratio of 1 male 3 female. From these mates 250 eggs were collected and stored at 15°C and incubated at 37,5°C 70% RH when the birds were at the 3 months old of age in each group and generation. Mean egg weight, embryonic mortality, weak offspring rate and albino birds rate were significantly higher and fertilized eggs rate, hatchability, survival rate and hen day egg production were lower in the closed group than crossbreeding group in both generations. The results indicated that viability and reproductive performance were decreased due to inbreeding in small and closed flock. As a conclusion, crossbreeding should be occasionally done for ameliorating the negative effects of inbreeding in small and closed flocks.

Key words: Quail, closed breeding, reproductive performance, inbreeding

INTRODUCTION

Genetic improvement of livestock and poultry is based on two alternative approaches; crossbreeding and selection. Crossbreeding leads to an increase in genetic variation and heterozygosity in a population (Szwaczkowski *et al*., 2003). By contrast, selection results in both genetic gain and inbreeding due to increased homozygosity. The increased homozygosity in a population may lead to decrease in performance and fitness trait which is defined as inbreeding depression (Miglior *et al*., 1995; Charlesworth and Charlesworth, 1987). On the other hand, mating of relatives has been used to produce breeds, varieties and lines (Nwagu *et al*., 2007). However, mating between close relatives increases the proportion of loci at which individuals are homozygous, because such pairs are genetically more similar to each other than those randomly taken from the population (Rall *et al*., 1986). Several studies on the effect of inbreeding on reproductive and productive performance of livestock and poultry populations has been reported (Szwaczkowski *et al*., 2003; Nwagu *et al*., 2007). These studies have shown that one of the main deleterious effects of high inbreeding coefficient is the reduction of fertility and offspring survival (Ballou and Ralls, 1982; Hass, 1989). Therefore, from the current perspective, the inbreeding rate is perceived as negative, especially for small, closed populations. Hence mating designs are developed to constrain the inbreeding level (Oyama and Mukai, 1998; Nomura, 1998). Contrary to livestock, laying hens are characterized by short generation interval, which leads to an increase in the inbreeding rate (Szwaczkowski *et al*., 2003).

The objective of this study was to evaluate the effects of closed breeding on some reproductive performance in a small quail flock which had been bred for ten years.

MATERIALS AND METHODS

Initial strain of the study was obtained from a small (average 400 laying quail) closed commercial flock which was randomly bred for ten years. Firstly 72 laying female birds at three months of age were obtained from the commercial flock and randomly separated into two groups (closed and crossbreeding). Closed group was mated with

Corresponding Author: M. Yerturk, Department of Animal Science, Faculty of Veterinary Medicine, Harran University, 63300 Sanliurfa, Turkey

Table 1: Ingredients and chemical composition of the starter, grower and basal diet

Ingredients (%)	Starter 1-3 (week)	Grower 4-6 (week)	Laying 6-12 (week)
Yellow corn	46.00	53.70	47.00
Wheat	11.00	11.00	10.00
Soybean meal (44% CP)	34.45	30.00	31.00
Fish meal (60% CP)	5.00	1.20	1.50
Vegetable oil	1.50	1.20	3.15
Calcium carbonate	0,45.00	1.00	5.50
Dicalcium phosphate	1.00	1.30	1.25
Salt	0,3.00	0.30	0.30
Vitamin mineral premix[a]	0.30	0.30	0.30
Total	100.00	100.00	100.00
Analyzed values (%)			
DM	89.30	89.70	90.00
Crude protein	23.95	20.04	20.00
Calcium	0.80	0.88	2.54
Total phosphorus	0.60	0.59	0.61
Calculated values (%)			
ME (Kcal kg^{-1})	2900.00	2900.00	2906.00
Lysine	1.34	1.05	1.07
Methionine+cystine	0.79	0.66	0.70

[a]Vitamin mineral premix (provided the following per kg diet): Vitamin A, 12500 IU; Vitamin D3, 1500 IU; Vitamin E, 31.25 mg; Vitamin K3, 3.75 mg; Vitamin B1, 2.5 mg; Vitamin B2, 7.5 mg; Niacin 25 mg; Cal. D-pantothenate 10 mg; Vitamin B6, 5mg; Vitamin B12, 0.019 mg; Folic acid 1 mg; Choline chloride 250 mg; Mn 100 mg; Fe 75 mg; Zn 75 mg; Cu 6.25 mg; Co 0.25 mg; I, 1.25 mg;Se 0.19 mg

their own male, crossbreeding group mated with males that bringing from different flock to form the first generation material and then each group mated with their own male to form second generation animal material in a ratio of 1 male 3 female.

Two hundred and fifty eggs were collected for incubation when the birds were at the 3 months old of age obtained from these mates in each group and generation stored at 15°C and incubated at 37.5°C, 70% RH. After hatching; all chicks were weighed and the number of chicks and unhatched eggs were recorded. The numbers of fertile eggs, infertile eggs, total death embryos were determined macroscopically by breaking of the unhatched eggs.

The chicks were fed with a starter diet until 21 days of age and then a grower diet until 42 days of age. Mature birds were fed a basal diet. Chemical compositions of the diets were analyzed using the international procedures of AOAC (1984). Ingredients and chemical composition of the starter, grower and basal diet are presented in Table 1.

The diets and fresh water were available ad libitum. Continuous lighting exposure was provided until 2 weeks of age and 14 h dark 10 h light between 3rd and 6th weeks. The light period thereafter was increased 1 h every three day until it was fixed at 17 h per day in mature birds.

The chicks were kept in brooding batteries of 60×40×20 cm size, until the end of third week of age and then transferred into breeding pens of 120×50×25 cm size. The ambient temperature was maintained at about 32°C during the first week and diminished gradually to 25°C until 3rd week and 15-25°C from the 3rd week until the end of the experiment. The mature birds were housed in an 8 m × 7 m quail house equipped with 2 cages with wire mesh floor. Each cage had 3 subcages comprising 16 mature birds. The eggs of all groups were collected daily and weighed throughout the experiment.

Ambient temperature and humidity in the poultry house was recorded twelve times a day with an electronic instrument (TESTO 175) in mature quail. Average ambient relative humidity and mean value of daily temperatures of hen house were 46±5.6% and 19±3.6 in the first generation and, 44±4.1 and 20±2.8°C in second generation, respectively.

Data of egg weights, birth weight and hen day egg production were statistically analyzed by independent sample t-test fertilized eggs rate, embryonic mortality, hatchability, survival rate (until 7 weeks of age), hen day egg production and weak chicks rate were statistically analyzed by Chi-square test by using SPSS (1999) software package.

RESULTS AND DISCUSSION

The Reproductive performances of the birds in the first and second generations of closed and crossbreeding group were presented in Table 2 and 3. The results showed that the mean egg weight ($p<0.001$) and mean birth weight ($p<0.05$) of closed group were significantly higher than crossbreeding group in the first generation. However, in the second generation only mean egg weight was significantly ($p<0.001$) higher in closed group than crossbreeding group. The results of the study contradicted to the results of former researchers who reported that inbreeding decreased egg weight in the poultry (Cahaner *et al*., 1980; Ozdemir and Poyraz, 2000). The differences in egg weight between groups may in part be attributed to the levels of egg weights of groups and to the selection of larger eggs for incubation in the commercial flock. The mean egg weight of crossbreeding group was lover than closed groups.

Fertilized eggs rate ($p<0.05$), survival rate ($p<0.05$) and hen day egg production of crossbreeding ($p<0.001$) were significantly higher than closed groups. Significance levels of these three parameters were not changed in the second generations. The results of the study were in agreement with those of Piao *et al*. (2002, 2004), Marks (1979), Okamoto *et al*. (1982), Darden and Marks (1988) and Nestor *et al*. (1996) who reported that fertility, survival rate and hen day egg production decreased in the lines undergoing artificial selection or body weight and that this inbreeding depression

Table 2: Reproductive performance of closed and crossbreeding groups in the first generation

	Strains						
	Closed			Crossbreeding			
Traits	n	Values	Sx	n	Values	Sx	p-value
Mean egg weight (g)	2212	9.88	±0.07	2369	9.48	±0.08	***
Mean birth weight (g)	139	7.61	±0.08	179	7.32	±0.09	*
Fertilized eggs rate (%)	250	74	-	250	83	-	*
Embryonic mortality (%)	185	24,9	-	207	13.5	-	**
Hatchability (%)	185	75.1	-	207	86.5	-	**
Survival rate (%)	139	66.5	-	179	77.6	-	*
Hen day egg production (%)	36	70.46	±0.39	36	74.15	±0.40	***
Weak offspring rate (%)	139	13.7	-	179	5	-	***
Albino birds rate (%)	139	4.3	-	179	-	-	-

NS: p>0.05; *: p<0.05; **: p<0.01, ***: p<0.001

Table 3: Reproductive performance of closed and crossbreeding groups in the second generation

	Strains						
	Closed			Crossbreeding			
Traits	n	Values	Sx	n	Values	Sx	p-value
Mean egg weight (g)	2124	9.77	±0.07	2238	9.16	±0.09	***
Mean birth weight (g)	136	7.44	±0.07	173	7.23	±0.09	NS
Per cent of eggs fertilized (%)	250	69	-	250	81	-	*
Embryonic mortality (%)	180	24,4	-	202	14.4	-	*
Hatchability (%)	180	76.6	-	202	85.6	-	*
Survival rate (%)	136	69.8	-	173	79.7	-	*
Hen day egg production (%)	36	68.11	±0.31	36	71.46	±0.38	***
Weak offspring rate (%)	136	12,5	-	173	5.8	-	***
Albino birds rate (%)	136	5.9	-	173	-	-	

NS: p>0.05; *: p<0.05; **: p<0.01, ***: p<0.001

depended on the selection method and on the size of the population. The results indicated that closed breeding in the small flock for ten years increased inbreeding so; decreased the per cent of eggs fertilized, survival rate of birds and hen day egg production.

The differences in hen day egg production and fertilized eggs rate between groups may in part be attributed to the heterosis effects and the levels of egg production of groups. Several authors have reported heterosis for egg production (Minvielle *et al*., 2000; Moritsu *et al*., 1997; Okamoto *et al*., 1982). They also determined that the effect of heterosis was more remarkable after the age of 6 months. Marks (1979) and Okamoto *et al*. (1982) found heterosis for fertile eggs when the dam of the cross comes from the line with higher fertility. On the contrary, Sato *et al*. (1989) conducted close inbreeding and found negative heterosis in the F_1 of inbred lines.

Hatchability values of closed group were 75.1 and 76.6 and those of crossbreeding were 86.5 and 85.6, for the first and second generations, respectively. The hatchability values of closed group were significantly lower than crossbreeding group both for the first and second generations ($p<0.01$ and $p<0.05$) The lower hatchability in the closed group might be due to harmful effects of the inbreeding resulted from the close breeding for 10 years. Sato *et al*. (1989) and Piao *et al*. (2004) determined heterosis for hatchability up to 6 weeks of age.

Embryonic mortality, weak offspring rate and albino bird's rate in closed group were higher than crossbreeding group in the first and second generation. These results of the closed group were most remarkable characters of the study. Most of the weak chicks hatched between the 16th and 18th day and they were too weak to feed when placed to the brooder on the afternoon of the 19th day of incubation.

Albino bird's rate in the closed group was 4.3 and 5.9% in the first and second generations, respectively. However albino phenotype was not observed in the crossbreeding group in both generations. Therefore, comparison of the groups could not be done. The frequency of albino gene of closed group can be calculated as 20 and 24% for first and second generations, respectively.

Differences in embryonic mortality and weak offspring rate between groups may be due to the harmful

effects of inbreeding that comes from the closed breed for ten year (Hagger *et al*., 1986; Flock *et al*., 1993; Nomura, 1998). The high frequency of the allele responsible for the albino phenotype might be due to increase of inbreeding in the closed flock or to the frequency of the allele in the founder population. Rall *et al*. (1986) reported that Mating between close relatives increases the proportion of loci at which offspring are homozygous because such pairs are genetically more similar to each other than are pairs of individuals taken at random from the population.

CONCLUSION

As a result of close breeding for ten years, the inbreeding ratio of the flock increased so that the survival rate, hatchability, hen day egg production were decreased, weak offspring rate and frequency of albino gene increased in the closed and small commercial flock. Because of serious negative effects on reproductive performance crossbreeding should be done in a closed and small flock from time to time.

REFERENCES

AOAC, 1984. Official Methods of Analysis of the Association of Official Analytical Chemistry, 14th edition, Virginia.

Ballou, J. and K. Ralls, 1982. Inbreeding and juvenile mortality in small populations of ungulates: A detailed analysis, Biol. Conservation, 24: 239-272.

Cahaner, A., H. Abplanalp and F.T. Shultz, 1980. Effect of Inbreeding on Production Traits. Poult. Sci., 59: 1353-1362.

Charlesworth, D. and B. Charlesworth, 1987. Inbreeding depression and its evolutionary consequences. Ann. Rev. Ecol. Syst., 18: 237-268.

Darden, J.R. and H.L. Marks, 1988. Divergent selection for growth in Japanese quail under split and complete nutritional environments: 1. Genetic and correlated responses to selection. Poult. Sci., 67: 519-529.

Flock, D.K., H. Ameli and P. Glodek, 1993. Inbreeding and heterosis effects on quantitative traits in white leghorn population under long-term reciprocal recurrent selection. Br. Poul. Sci., 32: 451-462.

Hagger, C., D. Steiger-Stafl and C. Margurat, 1986. Embryonic mortality in chicken eggs as influenced by egg weight and inbreeding. Poult. Sci., 35: 812-821.

Hass, C.C., 1989. Bighorn lamb mortality: predation, inbreeding and population effects, Canadian J. Zool., 67: 699-705.

Marks, H.L., 1979. Changes in unselected traits accompanying long-term selection for fourweek body weight in Japanese quail. Poult. Sci., 58: 269-274.

Miglior, F., E.B. Burnside and J.C.M. Dekkers, 1995. Inbreeding of Canadian holstein cattle. J. Dairy Sci., 78: 1163-1167.

Minvielle, F., J.L. Monvoisin, J. Costa and Y. Maeda, 2000. Long-term egg production and heterosis in quail lines after within-line or reciprocal recurrent selection for high early egg production Br. Poult. Sci., 41: 150-157.

Moritsu, Y., K.E. Nestor, D.O. Noble, N.B. Anthony and W.L. Bacon, 1997. Divergent Selection for body weight and yolk precursor in Coturnix coturnix japonica: Heterosis in reciprocal crosses between divergently selected lines. Poult. Sci., 76: 437-444.

Nestor KE, W. Bacon, N.B. Anthony and D.O. Noble, 1996. Divergent Selection for body weight and yolk precursor in Coturnix coturnix japonica: Correlated responses to selection over thirty generations, Poult. Sci., 75: 472-477.

Nomura, T., 1998. A mating system to reduce inbreeding in selection programmes: Theoretical basis and modification of compensatory mating. J. Anim. Breeding and Genetics, 116: 351-362.

Nwagu B.I., S.A.S. Olorunju, O.O. Oni, L.O. Eduvie, I.A. Adeyinka, A.A. Sekoni and F.O. Abeke, 2007. Inbreeding effect on performance of rhode ýsland chickens selected for part- period egg production. Int. J. Poult. Sci., 6(1): 13-17.

Okamoto, S., Y. Hatate and T. Matuo, 1982. Heterosis in reciprocal crosses between large and small lines of Japanese quail, (Coturnix coturnix japonica). Jpn J. Zootech. Sci., 53: 424- 428.

Oyama, K. and F Mukai, 1998. Determination of the optimum mating design with constraints on inbreeding level and mating frequency of sires via a simple genetic algorithm. Anim. Sci. Technol., 69: 333-340.

Ozdemir, E. and Ö. Poyraz, 2000. Effects of inbreeding on some production traits of quails. J. Lalahan Anim. Res. Institute, 40 (1): 48-64.

Piao, J., S. Okamoto, S. Kobayashi, Y. Wada and Y. Maeda, 2002. Study of heterosis effects on productive traits of Japanese Quails: Heterosis effects on the crosses between large line and randombred population, Jpn Poult. Sci., 39: J139-J146.

Piao, J., S. Okamoto, S. Kobayashý, Y. Wada and Y. Maeda, 2004. Purebred and crossbred performances from a Japanese quail line with very small body size. Anim. Res., 53: 145-153.

Ralls, K., P.H. Harvey and A.M. Lyles, 1986. Inbreeding in natural populations of birds and mammals. Conservation Biology: The Science of Scarcity and Diversity. Sinauer, Sunderland, pp: 35-56.

Sato, K., H. Fukuda, Y.E. Hedianto and T. Ino, 1989. Research Note: Heterosis for reproductive traits in reciprocal crosses of highly inbred lines of Japanese quail. Jpn Poult. Sci., 26: 70-73.

SPSS, 1999. Spss for Windows, Release 10.0.1 standard version. Copyright by SPSS Inc.

Szwaczkowski, T., C.B. Katarzyna and W. Stanislaw, 2003. A note on inbreeding effects on productive and reproductive traits in laying hens. Anim. Sci. Papers and Reports, 21: 121-129.