Kafkas Univ Vet Fak Derg
18 (3): 425-430, 2012
DOI:10.9775/kvfd.2011.5619

RESEARCH ARTICLE

Effects of Mass Selection Based on Phenotype and Early Feed Restriction on the Performance and Carcass Characteristics in Japanese Quails [1]

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[1] *The research with the project number of 2005.02.0121.005 was supported by the Akdeniz University Scientific Research Projects Management*

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Makale Kodu (Article Code): KVFD-2011-5619

Summary

This study included Japanese quail flock subjected to mass selection for four generations to increase live-weight and a control flock that randomly mated for four generations. The effects of selection and early feed restriction on live-weight, feed consumption, feed conversion and carcass traits were investigated. In terms of live-weight, higher mean values were observed for quail flock subjected to selection in all weeks. It was detected that feed restriction has no effect on weekly live-weight and feed consumption. In addition, restrictedly fed quails more effectively benefitted from feeds in the 3rd and 4th weeks. Carcass, edible inner organ, and abdominal fat weight of quails subjected to selection were found as 137.51, 8.94, and 1.17 g, respectively. The same traits were determined for quails in control group as 116.08, 7.89, and 1.08 g, respectively. It was concluded that feed restriction by producers for species like quails of which the sexual maturity age and cutting age were close to each other would not yield any economic gain, and short-term mass selection could increase carcass weight by around 20%.

Keywords: *Japanese quail, Mass selection, Feed restriction, Carcass characteristics*

Japon Bıldırcınlarında Kitle Seleksiyonunun ve Erken Dönem Yem Kısıtlamasının Performans ve Karkas Özelliklerine Etkileri

Özet

Bu çalışmada, 4 kuşak canlı ağırlığı arttırma amacıyla kitle seleksiyonu uygulanmış bir Japon bıldırcını sürüsü ile 4 kuşak rastgele çiftleşmiş bir kontrol sürüsü kullanılmıştır. Sürülerde seleksiyonun ve erken dönemde uygulanan yem sınırlamasının canlı ağırlık, yem tüketimi, yemden yararlanma ve karkas özelliklerine etkileri araştırılmıştır. Canlı ağırlık bakımından tüm haftalarda seleksiyon uygulanmış bıldırcınlar için daha yüksek ortalamalar tespit edilmiştir. Yem kısıtlama uygulamasının haftalık canlı ağırlık ve yem tüketimi üzerine herhangi bir etkisi bulunmamıştır. Bunun yanında kısıtlı yemlenen bıldırcınlar 3. ve 4. haftalarda yemden daha etkin yararlanmıştır. Karkas, yenilebilir iç organ, abdominal yağ ağırlıkları seleksiyon yapılmış bıldırcınlarda sırasıyla 137.51, 8.94, 1.17 g olarak tespit edilmiştir. Aynı özellikler kontrol grubu bıldırcınlarda sırasıyla 116.08, 7.89, 1.08 g olarak bulunmuştur. Bıldırcın gibi eşeysel olgunluk yaşı ile kesim yaşı birbirine çok yakın olan bir türde yem kısıtlamasının üreticiler tarafından uygulanmasının herhangi bir ekonomik getiri sağlamayacağı, bunun yanında 4 kuşaklık kısa dönemli kitle seleksiyonunun karkas ağırlığını yaklaşık %20 arttırılabileceği ortaya konulmuştur.

Anahtar sözcükler: *Japon bıldırcını, Kitle seleksiyonu, Yem kısıtlaması, Karkas özellikleri*

INTRODUCTION

Some of the studies on Japanese quails aimed to obtain information that might be utilized in production in terms of the improvement of the characteristics with economic significance, whereas some of them aimed to elucidate the basic issues that will also apply to other domestic poultry. Considering the stimulation of various sources of production to meet the need of societies for animal food, quail production has been seriously considered in the recent

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years. In Japanese quails, environmental requirements are few and production costs are rather low. The quails with quite good meat and egg yields are generally reared for egg yield in the Far Eastern and Asian countries and primarily for meat production in Europe and the U.S.A. [1]. In some countries like Turkey, Japanese quails are reared for meat production generally at family type small-scale enterprises in villages. At these enterprises, quails are not priced according to their weights but per piece and then offered to the market [2]. Thus, without grown much, quails are slaughtered at young ages like at 4-5 weeks of age and sold. Unlike this case, consumers do not prefer quails with a low carcass weight and wish to purchase heavier quails. Due to competition, some enterprises slaughter the quails at older ages; however, this causes an increase in feed consumption. Consequently, producers experience loss because of pricing per piece.

It is possible to obtain good results in a short period of time through appropriate breeding strategies to increase carcass weight and to improve carcass quality. In a study carried out in the Antalya province of Turkey, it was determined that no breeding activities were performed in the breeder flocks the villagers used in production and that these flocks consisted of randombred animals [2]. However, it is rather difficult to keep pedigree records, to estimate genetic parameters and to apply selection by obtaining breeding values with modern methods, such as BLUP or selection index, in the breeder flocks belonging to the small-scale enterprises in villages and consisting of few quails. Instead, the producers in rural areas are recommended to apply mass selection through the use of phenotypic values as the breeding values. The breeding values obtained using phenotypic values particularly for the characteristics with a high degree of heritability, such as body weight and carcass weight, are found quite close to the values obtained with the BLUP method [3].

To reduce the problems, such as bone deformation, articular fracture, ligament rupture, sudden death syndrome and excessive fat deposition, that take place as a result of the genetic improvement studies applied in the poultry for the body weight and slaughter characteristics, feed restriction aiming to control development is applied [4-6]. Besides, in some studies it was reported that when feed restriction was applied, compensatory growth was observed and as a result of this, improvement was observed in some characteristics, such as feed efficiency and carcass yield [4]. Even though there are numerous studies where the effect of feed restriction on the performances of broilers and turkeys is investigated, the number of studies on quails is rather small.

A quail flock treated with mass selection to increase body weight for 4 generations and a control flock randombred for 4 generations were used in this study. The effects of selection and feed restriction applied in the early period on the body weight, feed consumption, feed efficiency and carcass characteristics were investigated in the flocks concerned. Therefore, it was aimed to make recommendations to the family enterprises producing quails under village conditions.

MATERIAL and METHODS

An experiment was carried out in a curtained quail coop located at the Research and Application Unit in Department of Animal Science, Faculty of Agriculture, Akdeniz University. The management and handling of the birds were performed according to the practices as required by the Akdeniz University and by the European Convention for the Protection of Animals Kept for Farming Purposes.

In the study, the 4th week body weight was used as the selection criterion, and a selection flock (S line) selected for 4 generations as well as a control flock (C line) randombred for 4 generations were used. In the selection flock, phenotypic values were used for the breeding values and 30% of the females with the highest value and 10% of the males with the highest value in each generation were selected as the parents of the next generation. Some 60 chicks from each of the S and C lines in mixed sexes were randomly selected from the incubator; wing numbers were attached; and they were placed in the growing cages. Illumination based on the natural day length was applied in the experimental unit for compliance with the producers' conditions (14 h light, 10 h dark), and the ambient temperature and the humidity were measured as 26°C and 60%, respectively.

The cages used in the experiment contained a stocking area of 160 cm^2, a nipple drinker and a feeder per quail. The birds were fed a diet containing 240 g of CP and 12.1 MJ ME/kg feed *ad libitum*. For the application of feed restriction, some 30 quails from each of both flocks were unfed for 5 hours between 8 a.m. and 1 p.m. only on the 9th, 10th, 11th, 12th and 13th days. The other 60 quails were fed ad libitum throughout the whole experiment and the groups treated with feed restriction were fed ad libitum except for the above-mentioned days. During the experiment, the individual body weights were weighed weekly, whereas feed was weighed daily. At four weeks of age the all birds were sent to the slaughterhouse. After weighing each quail, they were killed by hand and their blood was drained, and procedures including wet plucking and evisceration were applied by hand. Subsequently, the weights of the hot carcasses, edible inner organs and abdominal fat, were determined. The data obtained from the experiment were analyzed by using PROC GLM of SAS software with analysis of variance (ANOVA). Following model was used for determination of the effect of treatment groups on studied traits.

$Y_{ijk}=\mu+L_i+F_j+(L*F)_{ij}+e_{ijk}$

Y_{ij} : represents the studied traits

L_i : effect of i^{th} line

F_j : effect of j^{th} feeding

$L*F_{ij}$: interaction effect of i^{th} line and j^{th} feeding

e_{ijk} : error term

Because feed restriction was applied in the 2nd week, analyses were made by excluding the effect of feeding from the model above in the statistical analysis of the characteristics measured previously. Significant differences among the group means (C line-ad libitum, C line-restricted, S line-ad libitum, S line-restricted) were seperated using Duncan's multiple range test with a 1% probability.

RESULTS

The effects of selection-feed restriction on weekly body weight, feed intake, and feed conversion ratio of Japanese quail are summarized in *Table 1*. In terms of body weight, higher averages were detected in the S line in all weeks than in the C line (P<0.01). The body weight averages were found as 7.40, 23.44, 67.98, 111.51 and 152.38 g in the C line in the 1st, 2nd, 3rd and 4th weeks, respectively, while they were found as 9.22, 33.18, 83.73, 134.05 and 179.04 g in the S line, respectively. The application of feed restriction had no effect on the weekly body weight and feed consumption. The selected quails consumed more feed than the C line in all weeks other than the week, when feed restriction was applied (P<0.01). Also when the total feed consumption was examined, it was determined that the S line had a higher average than the C line (P<0.01). The feed efficiency rates of quails were calculated as 1.73, 2.04, 2.49 and 3.47 in the S line in the 1st, 2nd, 3rd and 4th weeks, respectively, whereas they were computed as 2.12, 2.34, 2.61 and 3.66 in the C line, respectively. It was determined that in terms of both weekly and cumulative feed efficiency rates, the selected quails benefited from feed more efficiently (P<0.01). Those quails which were fed ad libitum in the 3rd and 4th weeks following feed restriction had feed conversion ratios of 2.62 and 3.64, whereas the feed conversion ratios were calculated as 2.48 and 3.49 in the quails treated with feed restriction. This difference was found statistically significant (P<0.01). However, restricted feeding had no effect in terms of cumulative feed efficiency.

The carcass, edible internal organ and abdominal fat weights of the quails and their values proportioned to body weight are presented in *Table 2*. The effect of interaction between the selection and feeding variables was found significant for none of the characteristics. The carcass, edible internal organ and abdominal fat weights were detected as 137.51, 8.94 and 1.17 g in the selected quails, respectively.

Table 1. *Means of weekly body weights, feed intakes and feed conversion ratios of groups*
Tablo 1. *Grupların haftalık canlı ağırlık, yem tüketimi ve yem dönüşüm oranlarının ortalamaları*

Week	C Line		S Line		SEM	Significance of Effects		
	Adl	Fr	Adl	Fr		Selection	Feeding	S*F
Body Weight (g)								
H*	7.40^{b}	7.39^{b}	9.27^{a}	9.17^{a}	0.07	0.000	-	-
1	22.94^{b}	23.93^{b}	32.42^{a}	33.93^{a}	0.34	0.000	-	-
2	68.75^{b}	67.21^{b}	84.16^{a}	83.29^{a}	0.84	0.000	-	-
3	111.13^{b}	111.89^{b}	134.43^{a}	133.66^{a}	1.23	0.000	NS	NS
4	150.93^{b}	153.82^{b}	178.42^{a}	179.65^{a}	1.79	0.000	NS	NS
Feed Intake (g)								
1	33.57^{b}	34.40^{b}	41.21^{a}	41.35^{a}	0.32	0.000	-	-
2	103.99	104.30	102.45	103.16	0.55	NS	-	-
3	114.00^{b}	113.04^{b}	127.69^{a}	122.40^{a}	0.46	0.002	NS	NS
4	147.66^{b}	150.95^{b}	156.60^{a}	155.45^{a}	0.46	0.007	NS	NS
1-4	400.37^{b}	401.86^{b}	426.75^{a}	423.72^{a}	2.46	0.000	NS	NS
Feed Conversion Ratio								
1	2.16^{a}	2.08^{a}	1.78^{b}	1.67^{b}	0.04	0.000	-	-
2	2.27^{ab}	2.41^{a}	1.98^{b}	2.09^{b}	0.03	0.000	-	-
3	2.69^{a}	2.53^{b}	2.54^{b}	2.43^{c}	0.11	0.002	0.004	NS
4	3.71^{a}	3.60^{b}	3.56^{b}	3.38^{c}	0.12	0.008	0.001	NS
1-4	2.78^{a}	2.75^{a}	2.53^{b}	2.48^{b}	0.07	0.003	NS	NS

**H = Hatching, C = Control, S = Selection, Adl = Ad-libitum, Fr = Feed restriction*
$^{a-c}$ = Means within the same row with different superscripts are significantly different (P<0.01)

Table 2. *Group means of the slaughter traits under consideration*
Tablo 2. *Üzerinde durulan kesim özelliklerinin grup ortalamaları*

Trait	C Line		S Line		SEM	Significance of Effects		
	Adl	Fr	Adl	Fr		Selection	Feeding	S*F
Weighted (g)								
Carcass	115.25[b]	116.92[b]	136.94[a]	138.08[a]	1.02	0.000	NS	NS
Edible inner organs	7.91[b]	7.88[b]	8.92[a]	8.96[a]	0.16	0.000	NS	NS
Abdominal fat	1.10[b]	1.06[b]	1.18[a]	1.17[a]	0.75	0.000	NS	NS
Proportioned (% body weight)								
Carcass	76.36	76.01	76.75	76.86	0.18	NS	NS	NS
Edible inner organs	5.24	5.12	5.00	4.99	0.07	NS	NS	NS
Abdominal fat	0.73	0.69	0.66	0.65	0.34	NS	NS	NS

**C = Control, S = Selection, Adl = Ad-libitum, Fr = Feed restriction*
[a-b] = Means within the same row with different superscripts are significantly different (P<0.01)

On the other hand, the same characteristics were recorded as 116.08, 7.89 and 1.08 g in the C line, respectively. For each of the three characteristics, the differences among the averages of the S and C lines were found statistically significant (P<0.01). No statistically significant difference was found among the averages calculated in the S and C lines for the carcass, edible internal organ and abdominal fat rates. The application of feed restriction had no effect on either weight or proportional values of the carcass characteristics.

DISCUSSION

The weekly body weight averages detected in both C and S lines in the research are in agreement with the results of similar studies where short-term selection is applied [7-9]. Due to the short-term mass selection, 25%, 42%, 23%, 20% and 18% increases occurred in terms of hatching, the 1st, 2nd, 3rd and 4th week body weights, respectively. The finding of differences in the hatching weight and in the ages of the first three weeks as a result of the selection applied for the fourth week body weight occurs due to the positive high genetic correlation among the weekly body weights [10]. The 4th week body weight averages, the selection criteria, were determined as 152.38 g and 179.04 g in the C and S lines. Oguz et al.[11], who applied selection for 5 generations according to the fourth week body weight, reported that a 19.5% increase occurred in the 4th week body weight (control line: 133.64 g and selection line: 159.69 g). Reddish [12] and Aggrey [13] detected similar results in their selection studies. In addition, Marks [13], who applied selection for 51 generations in terms of the fourth week body weight, reported the body weight averages of the control and selection groups as 86.50 g and 218.80 g. These results reveal that the short-term mass selection carried out for the 4th week body weight led to a significant increase in the body weight averages.

In the study it was determined that the quails in the S line consumed more feed than the quails in the C line in all weeks other than the 2nd week. It was found that also in terms of the cumulative feed consumption, the quails in the S line consumed 6% more feed. In many studies it was reported that the selected quails with a high body weight consumed more feed [15-17]. Positive effects of selection were also detected in terms of feed efficiency. Better results were found for the quails in the S line in all weeks and in terms of the cumulative feed efficiency as compared to those in the C line. In agreement with this research, in a study by Marks [15] the long-term selected quail line for the 4th week body weight and the randombred control line were fed feed with different protein contents and it was reported that feed efficiencies for four weeks ranged from 2.34 to 2.41 in the selection line and from 2.72 to 2.91 in the control line.

The effect of short-term mass selection for increasing the body weight on the carcass, edible internal organ and abdominal fat weights was found significant. These findings are in agreement with the reports by Caron et al.[17], Marks [18], Oguz and Turkmut [8] and Oguz [19]. However, the effect of increasing the body weight with short-term selection on the proportional values of the characteristics concerned was found insignificant. Yolcu et al.[20] suggested that selection carried out to increase the body weight also caused an increase in the proportional values of the carcass and the carcass sections. Similar results were obtained in a study by Caron et al.[17]; however, the researchers suggested that this resulted from the fact that the selection line found to have a high carcass yield had a low abdominal fat rate.

No effect of feed restriction on the weekly body weight and feed consumption characteristics was detected in the research. Gebhard-Henrich and Marks [21], who applied 30% feed restriction in a long-term selected line and a randombred line, reported that feed restriction led to significant decreases in the body weight averages of the quails in both lines. Likewise, in their research, Kalpak and

Sogut [22] reported that the 4th week body weights of the quails treated with 20% and 30% feed restrictions were lower than those of the quails fed ad libitum. In the same research, it was stated that there was also a negative significant difference in terms of total feed consumption, but no difference was observed in terms of feed efficiency. In the long-term applications in which little feed is provided, a decrease in body weights is an expected situation. It is thought that the situation concerned does not have any economic contribution to the quails to be slaughtered at 4 weeks of age.

In the research, feed restriction had a positive effect on feed efficiency only in the 3rd and 4th weeks at the end of the restriction time. This supports the opinion of Plavnik and Hurwitz [23]. It is considered that the improvement in feed efficiency without any difference between body weight and feed consumption in the period concerned occurred with compensatory growth. Plavnik and Hurwitz [23], who applied feed restriction in broiler chicks, reported that the period of maintenance commenced following the feed restriction, which increased feed efficiency. Nevertheless, the effect of feed restriction on the quail groups in terms of cumulative feed efficiency was found insignificant in the study. It is rather difficult that the effects of feed restriction in the early period on the quails that reach sexual maturity in a short period of time as approximately 6 weeks be similar to those of the species, such as chicken or turkey, reaching sexual maturity in a longer period of time. Similar results were obtained in another study where a similar method to that of this study was applied [24]. In the broilers unfed for 4 hours for 14 days in the early period, the effect of restriction on the weekly body weight, feed consumption, cumulative feed efficiency, carcass yield and abdominal fat characteristics was found insignificant [24].

In commercial broiler and turkey production, feed restriction is an effective environmental method that has long been applied. Besides, selection is a genetic instrument that has been applied in modern poultry breeding for more than 100 years. In this study where both methods were applied in the Japanese quails, no significant effects of feed restriction were detected on the yield characteristics considered. Failure to detect the effects of the application of feed restriction on a species like quail, the sexual maturity age and the slaughter age of which are very close, is an expected situation. It is considered that its application by producers will not cause any economic contribution. However, mass selection is a method where phenotypic values are used as breeding values, which do not require complicated mathematical operations such as those in the BLUP and index methods, and which the producers can easily apply. With short-term mass selection, quail producers can perform selection for 4 generations in about a year. In the study it was determined that the carcass weight might be increased by 18.45% with the same method. It is considered that in countries where the carcasses are priced per piece, producers' following such a way will improve the product quality, which will enhance customer satisfaction.

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