

Phenotype Correlation of Carcass Traits in Three Japanese Quail Lines

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Abstract

This study aimed to evaluate the correlation between body weight and various carcass, non-edible, and internal organ traits in three genetically distinct lines of Japanese quail (white, brown, and gray) to inform selection strategies for carcass yield improvement. A total of 180 healthy chicks (60 per line) were reared under controlled conditions at the poultry farm of the Animal Production Department, College of Agriculture, Kirkuk University, from January to March 2023. At six weeks of age, 45 males (15 per line) were slaughtered for carcass evaluation. Pearson correlation coefficients were calculated using SPSS (v26.0) to assess the strength and direction of relationships among traits. Across all lines, body weight exhibited strong positive correlations with carcass weight ($r = 0.826$ to 0.855 ; $p \leq 0.001$) and chest muscle weight ($r = 0.555$ to 0.821), confirming these as reliable indicators of meat yield. Thigh weight also showed moderate to strong associations with body and carcass weights ($r = 0.337$ to 0.806). Back and wing weights demonstrated weaker or inconsistent correlations, particularly in brown and gray lines. Among non-edible parts, feet and neck weights showed moderate positive correlations with body weight, while head weight was uncorrelated across all lines. Gizzard and liver weights showed weak to moderate positive correlations with body weight, whereas heart weight showed inconsistent, generally weak associations. Notably, negative correlations were observed between heart and liver weights across lines. The findings emphasize the value of chest and thigh traits as selection targets in breeding programs. Additionally, internal organ correlations provide insight into physiological scaling relevant for optimizing production efficiency and bird welfare.

Keywords: Correlation, Carcass, Quail, Japanese, Line

Introduction

Japanese quail (*Coturnix japonica*) is a small galliform bird that has gained significant attention as a model species in poultry research and commercial Carcass and egg production due to its fast growth, early sexual maturity, high reproductive rate, and low maintenance requirements [1]. In the context of Carcass production, selection for superior growth and carcass traits in Japanese quail has become a

priority for breeders aiming to meet increasing market demand for lean and nutritious poultry Carcass [2, 3].

Carcass production traits such as body weight, chest muscle yield, thigh muscle yield, dressing percentage, and fat deposition are complex and influenced by both genetic and environmental factors [4]. Phenotypic correlation analysis among these traits plays a crucial role in understanding their interrelationships and guiding effective selection strategies in

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breeding programs [5]. For instance, a positive phenotypic correlation between body weight and carcass weight is often reported, suggesting that selection for higher body weight could improve total carcass yield [6,7]. However, other correlations, such as those involving fat content or feed conversion ratios, may have trade-offs that need to be carefully managed [8].

Various quail lines have been developed worldwide through selection for specific traits such as carcass yield [9], egg production [10], growth performance [11], or immune performance [12]. Carcass-type, egg-type, and control or wild-type quail lines exhibit distinctive phenotypic profiles for growth and carcass characteristics [13, 14].

Comparative studies among different genetic lines are essential to evaluate the potential of each line for Carcass production and to explore the genetic variability within and between populations [15, 16]. These studies also help to identify traits with high heritability and favorable correlations, which can be exploited in selective breeding programs. Moreover, understanding the phenotypic correlation among Carcass traits allows for multi-trait selection strategies that optimize overall performance rather than focusing on a single trait [17]. Integrating phenotypic correlations with genetic and genomic data further enhances the precision of selection programs [18].

The study investigations of the past have mainly focused on growth performance, carcass production, or genetic factors in the specific population of Japanese quail. However, there are few data available for comparison of phenotypic relationships among carcass traits for several genetic lines. Determining if these associations change when different lines are selected is important because selection effectiveness

may differ between different lines. The purposes of this study were to compare the correlation values of the various carcass traits for the white, brown and grey Japanese quail lines in a common environment. This information might aid in identifying characteristics that are commonly associated with carcass performance and assist breeders in designing more efficient breeding programs.

This study hypothesized genetic differences in body weight, body component, non-edible parts and internal organs relations among three genetically different lines of Japanese quail (white, brown and grey), which reflects distinct growth patterns and body composition. Many studies have been conducted on carcass characteristics of Japanese quail, but very little information exists on the comparative phenotypic correlation structure between different genetic lines under similar management in Japanese quail. The novelty of this study lies in the evaluation of and the comparison of the correlation pattern for the carcass related traits among three highly diverse genetically, Japanese quail lines, which are useful for future breeding and selection programs aiming at improving the carcass performance.

Material and Methods

The current study was done in the poultry farm of the animal production department-college of agriculture- Kirkuk university from (January, to March 2023), using three genetically distinct lines of Japanese quail, the white line, brown line, and gray line. A total of 180 healthy quail chicks (60 from each line) were selected immediately post-hatch and reared under uniform environmental and management conditions.

Birds were raised in environmentally controlled brooders for

the first three weeks, after which they were transferred to individual cages in a grower facility. The lighting regimen consisted of 23 hours' light and 1-hour dark during the brooding phase, followed by a 16L:8D schedule. Temperature was maintained at 35°C in the first week and gradually reduced to 24°C by the fourth week.

All birds were fed ad libitum with a standard commercial quail diet formulated to meet the NRC (1994) [19] nutrient requirements. The diet contained 24% crude protein and 2,900 kcal/kg metabolize energy during the starter phase (0–3 weeks), and 20% crude protein with 2,800 kcal/kg metabolize energy for the grower-finisher phase (4–6 weeks). Clean drinking water was provided throughout the study period.

At six weeks of age, 15 males from each line (totaling 45 birds) were randomly selected and fasted for 12 hours with access to water before slaughter. The birds were slaughtered humanely following ethical guidelines approved by the Institutional Animal Ethics Committee. Post-slaughter, the carcasses were de-feathered, eviscerated, and chilled at 4°C for 24 hours. The following Carcass traits were recorded: Live Body Weight, Carcass Weight, Chest Muscle Weight, Thigh Muscle Weight, Back and Wing Weight. All weights were recorded to the nearest 0.01 g using an electronic balance. Each carcass trait was expressed both in absolute terms (grams).

Descriptive statistics were calculated for each trait by line. Pearson correlation coefficients were computed between pairs of Carcass traits using SPSS (version 26.0) [20]. The level of correlation was interpreted as weak ($r \leq 0.30$), moderate ($0.30 \leq r < 0.70$), or strong ($r \geq 0.70$) [21].

Results and Discussion

The correlation matrix presented in Table 1 highlights significant associations between body weight and various carcass components across three genetic lines of Japanese quail. In all three lines, body weight exhibited strong positive correlations with total carcass weight ($r = 0.826$ to 0.855 , $p \leq 0.001$), indicating that heavier birds tend to produce more carcass mass. This trend is consistent with findings by [16], who reported a similar linear association between body weight and carcass yield in quail. Chest muscle weight showed a particularly strong correlation with both body weight ($r = 0.555$ to 0.821) and carcass weight ($r = 0.769$ to 0.841), reinforcing the chest as a critical contributor to overall Carcass yield. This aligns with the observations of [1], who emphasized the genetic potential for improving chest muscle in selective breeding programs.

Thigh weight also demonstrated moderate to strong correlations with body weight ($r = 0.337$ to 0.689) and carcass weight ($r = 0.550$ to 0.806), suggesting that thigh muscles are responsive to overall body mass and can be considered secondary selection traits in breeding programs, like what was observed by [5].

Conversely, the back and wings showed variable and sometimes weak or non-significant correlations with body weight and other traits, particularly in the second and third genetic lines. For instance, the correlation between back weight and wings was not significant in two lines ($p \geq 0.05$), indicating that these traits may be under distinct genetic or environmental influence, as noted by [6].

Additionally, wing weight displayed inconsistent correlations with body weight ($r = 0.392$ to 0.722), suggesting limited utility as a selection trait for Carcass yield.

Table 1. The correlation among the body weight, carcass Parts in three genetic lines of Japanese quail

Wings	Back	Thigh	Chest	Carcass	Body Weight	Traits	Line
					1	Body Weight	White
				1	0.855 ***	Carcass	
			1	0.841 ***	0.821 ***	Chest	
		1	0.799 ***	0.806 ***	0.689 ***	Thigh	
	1	0.536 ***	0.507 **	0.478 **	0.490 **	Back	
1	0.213 NS	0.685 ***	0.642 ***	0.695 ***	0.722 ***	Wings	
					1	Body Weight	Brown
				1	0.826 ***	Carcass	
			1	0.769 ***	0.555 ***	Chest	
		1	0.709 ***	0.560 ***	0.337 *	Thigh	
	1	0.078 NS	0.203 NS	0.395 **	0.455 **	Back	
1	0.060 NS	0.445 **	0.567 ***	0.450 **	0.407 **	Wings	
					1	Body Weight	Gray
				1	0.838 ***	Carcass	
			1	0.794 ***	0.650 ***	Chest	
		1	0.700 ***	0.550 ***	0.377 **	Thigh	
	1	0.342 **	0.380 **	0.386 **	0.532 ***	Back	
1	-0.041 NS	0.609 ***	0.629 ***	0.560 ***	0.392 **	Wings	

1. *** Correlation is significant at the 0.001 level; ** Correlation is significant at the 0.01 level; * Correlation is significant at the 0.05 level; ns Correlation is not significant.

Table 2 presents the Pearson correlation coefficients between body weight and non-edible parts (feet, head, and neck) across three genetic lines of Japanese quail. The analysis reveals a moderate and statistically significant correlation between body weight and feet weight across all lines ($r = 0.428$ to 0.578 ; $p \leq 0.01$ to $p \leq 0.001$). This suggests that increases in overall body weight are accompanied by proportional increases in foot mass, reflecting general body growth patterns consistent with previous studies on poultry morphology [5]. In contrast, the head weight shows no significant correlation with body weight in any line ($r = -0.134$ to 0.073 ; $p \geq 0.05$). This supports earlier findings that head size in birds is less variable and less responsive to overall body mass changes, likely due to early

skeletal development and genetic constraints [6].

The neck weight demonstrated significant and moderate positive correlations with body weight in all lines ($r = 0.387$, 0.542 , 0.625), indicating a consistent relationship across genetic backgrounds. The neck appears more responsive to body mass changes than the head, possibly due to its muscular structure contributing to posture and movement, which are influenced by body condition [16]. Interestingly, while feet and neck both show positive and significant correlations with body weight, the head does not follow this pattern. This distinction highlights that not all non-edible parts scale linearly with body size and emphasizes the need for selective breeding programs to consider both edible

and non-edible traits separately to optimize Carcass yield [1].

Table 2: The correlation among the body weight and the non-eaten parts in three genetic lines of Japanese quail

Nick	Head	Feet	Body Weight	Traits	Line
			1	Body Weight	White
		1	0.428 **	Feet	
	1	-0.018 NS	0.073 NS	Head	
1	0.158 NS	0.427 **	0.387 *	Nick	
			1	Body Weight	Brown
		1	0.578 ***	Feet	
	1	-0.036 NS	-0.134 NS	Head	
1	-0.094 NS	0.465 **	0.542 ***	Nick	
			1	Body Weight	Gray
		1	0.456 ***	Feet	
	1	-0.001 NS	-0.108 NS	Head	
1	-0.384 **	0.284 *	0.625 ***	Nick	

Table 3 summarizes the correlation coefficients between body weight and internal organ weights (heart, gizzard, and liver) across three genetic lines of Japanese quail. The relationships between body weight and internal organs were generally weak to moderate, with varying levels of statistical significance depending on the organ and genetic line. Across all lines, gizzard weight demonstrated a consistent positive correlation with body weight ($r = 0.371, 0.378, 0.483$), indicating that heavier birds tend to develop larger gizzards. This finding is supported by previous research, which showed that the gizzard, as a muscular organ involved in mechanical digestion, often scales proportionally with body size to meet increased digestive demands [22, 23]. The liver also showed significant positive correlations with body weight in two lines ($r = 0.328, 0.281$), though this relationship was weak and non-significant in one line ($r = 0.153$). These results align with findings

from [24], who reported that liver weight is influenced by both genetic factors and metabolic activity, often varying independently of overall body mass due to its sensitivity to diet and energy metabolism.

Heart weight displayed inconsistent and generally non-significant correlations with body weight ($r = 0.222$ to 0.434 ; $p \leq 0.01$), suggesting that cardiac development is less responsive to variations in body mass in quails. This observation matches earlier findings by [6], who noted that heart size is more genetically conserved and regulated by cardiovascular demand rather than overall body size. Interestingly, strong negative correlations were observed between heart and liver weights in all lines ($r = -0.329$ to -0.543), and between heart and gizzard in one line ($r = -0.338$), suggesting possible competitive growth or developmental trade-offs among internal organs, potentially influenced by genetic line and metabolic resource allocation [5, 25].

Table 3: The correlation among the body weights and the internal organs in three genetic lines of Japanese quail

Liver	Gizzard	Heart	Body Weight	Traits	Line
			1	Body Weight	White
		1	0.345 NS	Heart	
	1	-0.338 *	0.371 *	Gizzard	
1	0.645 ***	-0.543 ***	0.328 *	Liver	
			1	Body Weight	Brown
		1	0.434 **	Heart	
	1	-0.108 NS	0.378 **	Gizzard	
1	0.365 **	-0.501 ***	0.153 NS	Liver	
			1	Body Weight	Gray
		1	0.222 NS	Heart	
	1	-0.112 NS	0.483 ***	Gizzard	
1	0.729 ***	-0.329 *	0.281 *	Liver	

Conclusion

The results showed that body weight and carcass weight of the quail lines studied had positive correlation with chest and thigh weights. These characteristics could be useful as phenotypic markers of the carcass performance. These traits should be used directly in breeding programs, but additional research is needed to include genetic factors like heritability and genetic correlation.

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