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Some body variables and their relationships in blue-breasted quail *Synoicus chinensis*

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Abstract

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Blue-breasted quail (*Synoicus chinensis,* formerly *Coturnix chinensis* or *Excalfactoria chinensis*), has recently been defined as a good animal model for research in developmental biology, genetics, reproduction, behavior, and immunology due to its advantages, such as ease of handling, robustness, high egg-laying performance, observation of parthenogenesis, and short generation. The aim of this study was to determine body variables such as live weight, length of total body, length of exposed culmen, length of culmen without cere, windth of bill from the front of the cere, width of bill at gape, length of head, width of head, heigth of eye, length of closed wing, length of tarsus, length of middle toe, length of hallux and investigate the relationships between body variables and identify the most influential variable(s) causing the observed in blue-breasted quail. A total of 96 blue-breasted quails at 65–67 days of age were used. Live weight ($P = 0.000$), length of total body ($P = 0.004$), heigth of eye ($P = 0.000$) and length of closed wing ($P = 0.004$) were higher in females, while length of exposed culmen ($P = 0.008$) was higher in males. The remaining other body variables were not fount to be statistically different between sexes ($P > 0.05$). The correlation coefficients between some body variables in the two sexes were significant. A number of negative correlations were found to be significant for females ($P < 0.05$), while none of them were found to be significant for males. ($P > 0.05$). First two principal components accounted for 94.6% and 78.3% of the total variance in females and males, respectively, and the most effective variable in both genders was live weight. This study could be a source that will pave the way for future studies on the blue-breasted quail, which has recently been the subject of several studies because of its many variables, and which has not yet been selectively bred.

Keywords: Chinese painted quail; body variable; correlation; principal component

Introduction

The blue-breasted quail is a species of old-world quail in the family Phasianidae, the smallest species of the order Galliformes, native to the wild from India to Southeast Asia, and down into Australia (Pearson et al., 1998; Nishibori et al., 2002; Nakamura et al., 2019a). This quail is also called button quail in the USA, the King quail in Australia, and the Chinese painted quail in Europe. Other common names known as Indian blue quail, Asian blue-breasted quail, and blue quail (Schleidt et al., 1984; Sarkadi et al., 2013; Adkins-Regan, 2016). The scientific naming of this species is also complex, and it is seen that there are three scientific names, chronologically. These are previously *Excalfactoria chinensis* (Tsudzuki, 1994; Tsudzuki, 1995a; Tsudzuki, 1995b; King, 1970; Wei et al., 2011a), *Coturnix chinensis* (Shibusawa et al., 2004; Ono et al., 2005; Parker et al., 2010; Adkins-Regan, 2016; Nakamura et al., 2019b), and most recently *Synoicus chinensis* (van Grouw, 2017; Naskar et al., 2022).

The blue-breasted quail has proposed as an excellent model animal due to its small body size about thirty years ago (Tsudzuki, 1994). For more than two decades, these quails have been used in developmental biology, genetics, reproduction, behavior and immunology research (Nakamura et al., 2019a) due to their advantages, such as ease of handling, hardiness, high egg-laying performance, observation of parthenogenesis, short generation interval, early sex determination (Tsudzuki, 1994; Nishibori et al., 2002; Parker & McDaniel, 2009; Wei et al., 2011a; Kageyama et al., 2018; Nakamura et al., 2019b). Besides, blue-breasted quails are smaller in size than Japanese quails (Sarkadi et al., 2013), have remained species-specific behavioral characteristics even after domestication (Hickman, 1981) and have not been subject to selective breeding untill this time (Tsudzuki, 1994; Pearson et al., 1998). Although it does not have an economic value today, the meat and eggs of blue-breasted quail are edible valuable foods.

The egg production rate, hatchability, fertility, and viability up to maturity of blue-breasted quails were about 70, 91, 84, and 78 %, respectively (Tsudzuki, 1994). Pearson et al. (1998) reported the egg weight of this quail' as 5–6 g, while Pis & Lusnia (2005) found the average egg weight to be 5.33±0.458. Besides, Yiğit (2021a) reported that the average egg weight of quails is 5.742±0.014 for the first one-year production period. The mean shape index of blue-breasted quail eggs was reported as 77.5% (Johnsgard, 1988) and 76.830±0.086% (Yiğit, 2021a). In addition, egg weight, albumen weight, yolk weight, eggshell weight and eggshell thickness were found as 5.54 and 5.84 g, 3.36 and 3.55 g, 1.72 and 1.82 g, 0.46 and 0.47 g and 0.174 and 0.172 mm in young and old flocks, respectively (Yiğit, 2022). The color of the eggshell of this quail eggs has been reported as beige, grayish beige, reddish beige, greenish beige, bluish beige (Tzutsuki, 1994), cream, olive, brown and grayish (Yiğit, 2021b). The hen incubates and average number of clutch size 3.3, but sometimes this number can varies between 1 and 20 eggs (Parker & McDaniel, 2009).

The incubation period of blue-breasted quail eggs has been reported to be 16 to 17 days at an incubator temperature of 37.5 and 37.7°C (Nakamura et al., 2019a; Nakamura et al., 2019b; Cai et al., 2019). In this precocial species, poikilothermy in hatchlings with an average of 3-3.5 g gradually turns into homeothermy until they reach a weight of about 25 g at the age of four weeks (Berstein, 1973; Pis & Lusnia, 2005). Growing young blue-breasted quails reach sexual maturity when they are around 56 to 63 days old, with a body weight of about 50 g at this age (Ono et al., 2005). Similarly, it was stated that it is possible to determine the sex of quails from the age of 22 days, and the mean live weights of young male and female chicks at this age are 27.58 g and 30.34 g, respectively, and the sexes show similar weights. In addition, quails at the age of 59 days have reached the adult body weight and male quails with an average of 46.99 g at this age are significantly lighter than females with an average of 61.51 g. Moreover, it has been reported that the growth rates of the sexes are also different (Pis & Luśnia, 2005). Accordingly, they have reversed sexual size dimorphism, the female being larger than the male (Harper, 1986). There are also wild-type plumage color sexual dimorphisms with females displaying a brown color similar to Japanese quail, but males with a general blue pattern on the back, red tail and remarkable black and white markings on the cheek and throat (Tsudzuki, 1994; Araguas et al., 2018). However, feather color mutations such as red breasted (Araguas et al., 2018), white, cinnamon (Pis & Lus´nia, 2005), buff (Harrison, 1973), blue face (Araguas et al., 2018) or extended brown (Kageyama et al., 2018), light gray (Tsudzuki, 1995) or silver, speckled (pinto), tuxedo (Adkins-Regan, 2016) and golden pearl (Landry & Rogers, 1977) are common, because breeders give importance to different feather colors. Besides, the albino mutation was also observed.

There is limited literature on morphometric body measurements of blue-breasted quails. In the study in which quails with an average weight of 43.6 g were used, it was reported that the wing, disc and body frontal area were 94.2, 365.5 and 13.9 cm^2, respectively (Askew et al., 2001).

This study aimed to determine morphological characteristics such as live weight, length of total body, length of exposed culmen, length of culmen without cere, windth of bill from the front of the cere, width of bill at gape, length of head, width of head, heigth of eye, length of closed wing, length of tarsus (tarso-metatarsus), length of middle toe, length of hind toe (hallux) in blue-breasted quail. In addition, the study was conducted to investigate the relationships between body variables and to identify the most influential variable(s) causing the observed variation in blue-breasted quail.

Materials and Methods

Experimental birds, management and site

It has been reported that there may be a relationship between plumage color and performance in Japanese quail (Ibrahim et al., 2021), but no such information has yet been found in blue-breasted quail. Therefore, a total of 96 quails with different feather colours such as golden pearl, red-breasted, blue-faced, white, cinnamon, tuxedo, and wild, were used in the study. The quails were bred in the same environment and care conditions without selection at Isparta University of Applied Sciences, Faculty of Agriculture, Animal Husbandry Laboratory.

The temperature in each brooder heater was maintained at 41 ± 1°C, while the temperature in areas not affected by thermal radiation was maintained at about 35°C for the first 2 weeks, and then reduced by 2°C every 2 days to 22°C (Pis & Lus´nia, 2005; Wei et al., 2011b). The ambient temperature in the breeding room was 20–25°C and the relative humidity was 65–70%. The quails were exposed to light for 24 h from hatch to four weeks of age, followed by natural light (14L: 10D) for the remainder of the experiment (Williamson et al., 2014; Adkins-Regan, 2016). All experimental procedures were approved by the Animal Experiments Local Ethics Committee of Isparta University of Applied Sciences (Approval Number: (2021)-001).

Data collection

Live weight (V1) of blue-breasted quails was measured with a scale with a precision of 0.01 g, length of total body (V2) was measured with a ruler with a precision of 0.1 mm and the other morphological variables, length of exposed culmen (bill) (V3), length of exposed culmen without cere (V4), windth of bill at base (V5), width of bill at gape (V6), length of head (V7), width of head (V8), heigth of eye (V9), length of closed wing (V10), length of tarsus (tarso-metatarsus) (V11), length of middle toe (V12), length of hind toe (hallux) (V13) were measured with a digital caliper with a precision of 0.01 mm. All measurements were made by a single expert to eliminate the human factor in the measurements. The measurements were carried out over a three-day period, with an equal number of males and females of the same age on each day, and with 2 males left over on the last day. The lengths of body variables on a wild male are shown in Figure 1.

Morphometric body variables were measured as specified below:

- Length of total body (V2) is the distance from the tip of the beak to the claw tip of the middle toe (third toe) on the right foot, when the chicks are laid ventrally on a flat surface with the neck and leg maximally extended (Willemsen et al., 2008).
- LLength of exposed culmen (V3) is the length from the beginning of the forehead feathers at the upper midpoint of the culmen to the tip of the bill (Baldwin et al., 1931).
- LLength of exposed culmen without cere (V4), is the length from the middle anterior edge of the cere to the tip of the bill (Baldwin et al., 1931).
- LWidth of bill at base (V5) is the shortest distance from the cutting edge on one side, to the cutting edge on the opposite side, at the anterior margins of the cere.
- LWidth of bill at gape (V6) is the distance from the bottom of the head from one side of the mouth to the other, when the bill is closed (Baldwin et al., 1931).

Fig. 1. The photos of lengths of body variables of blue-breasted quail
V1: live weight; V2: body length of total body; V3: length of exposed culmen (bill), V4: length of exposed culmen without cere; V5: windth of bill at base; V6: width of bill at gape; V7: length of head; V8: width of head; V9: heigth of eye, V10: length of closed wing, V11: length of tarsus (tarso-metatarsus); V12: length of middle toe; V13: length of hind toe (hallux)

– LLength of head (V7) is a straight line, measured by squeezing the front of the forehead and the back of the head with a caliper.
– LWidth of head (V8) is the distance between the extreme points on the left and right of the skull, measured just behind the eyes (Atasoy et al., 2013).
– LHeigth of eye (greatest vertical diameter) (V9) is a straight line length between the lids of the open right eye (Baldwin et al., 1931).
– LLength of closed wing (V10) is a straight line from the farthest anterior point of the carpus, to the tip of the longest primary remex (Stewart, 1963).
– LLength of tarsus (tarso-metatarsus) (V11) is the distance from the front of the tarsometatarsal bone in the toe joint, to the end of the bone below the ankle joint (Ferrer & De Le Court, 1992).
– LLength of middle (third) toe (V12) is the length of the middle phalanx along its dorsal surface from the proximal articular surface, at the joint of the metatarsus, to the distal end of the toe, at the base of the claw (Dzubin & Cooch, 1992).
– LLength of hind toe (hallux) (V13) is from the point, where the upper edge joins the metatarsus, to the proximal end of the upper side (Baldwin et al., 1931).
– LThe variables of the eye, wing, tarsus and toes were taken from the right side of the bird.

Statistical analysis

Data collected from the experiment were statistically analyzed by one-way ANOVA. In the study, the statistically significance level was taken as 5%. The relationships between the variables were determined by Pearson-moment correlation coefficient.

In terms of the variables considered in the study, Principal Component Analysis (PCA) was performed to determine the most effective variable(s) causing the variation observed in blue-breasted quails. It has also been reported that PCA could be used to reduce the dimensionality of a data set consisting of a large number of interrelated variables and to retain most of the variation in the data set (Ringnér, 2008).

Correlogram graphs of the correlations were generated using codes, written in the programming language R. The other statistical analyses were performed with Minitab-21 Statistical Package Programme (2021).

Results and Discussion

Descriptive statistics of body variables by sex in blue-breasted quails are shown in Table 1. Live weight (P = 0.000), length of total body (P = 0.004), heigth of eye (P = 0.000) and length of closed wing (P = 0.004) were higher in females, while length of exposed culmen (P = 0.008) was higher in males. On the other hand, no significant difference was found between genders in terms of length of exposed culmen without cere (P = 0.612), windth of bill at base (P = 0.670), width of bill at gape (P = 0.183), length of head (P = 0.357), width of head (P = 0.208), length of tarsus (tarso-metatarsus) (P = 0.552), length of middle toe (P = 0.175) and length of hind toe (hallux) (P = 0.267) were not found to be statistically different between genders.

Table 1. Descriptive statistics of body variables by sex in blue-breasted quail

	Female				Male				
	Mean±SE	CV	Min.	Max.	Mean±SE	CV	Min.	Max.	P-Value
V1 (g)	59.04±1.15	13.35	46.90	78.50	49.98±0.45	6.26	42.40	59.30	0.000
V2 (mm)	20.51±0.06	1.92	19.80	21.60	20.18±0.09	3.13	18.30	21.40	0.004
V3 (mm)	10.89±0.11	7.22	9.06	12.55	11.29±0.09	5.85	9.66	12.61	0.008
V4 (mm)	6.57±0.05	5.56	5.72	7.28	6.61±0.06	6.65	5.68	7.76	0.612
V5 (mm)	3.80±0.04	7.26	3.10	4.40	3.77±0.05	9.86	2.68	4.52	0.670
V6 (mm)	8.47±0.12	9.88	6.73	10.11	8.67±0.09	7.16	7.31	10.05	0.183
V7 (mm)	18.16±0.14	5.26	16.10	20.48	18.34±0.13	4.83	16.66	21.16	0.357
V8 (mm)	11.27±0.10	6.04	9.89	13.43	11.42±0.08	4.76	10.51	13.52	0.208
V9 (mm)	4.55±0.05	8.27	3.82	5.75	4.22±0.05	7.69	3.43	4.99	0.000
V10 (mm)	7.47±0.03	2.93	6.90	7.90	7.38±0.03	2.92	6.80	7.70	0.040
V11 (mm)	22.99±0.15	4.41	19.84	25.31	22.87±0.13	4.03	19.75	24.89	0.552
V12 (mm)	18.14±0.14	5.41	14.46	19.99	17.89±0.11	4.32	16.57	20.03	0.175
V13 (mm)	5.17±0.06	8.49	4.15	6.06	5.06±0.07	10.12	4.02	5.98	0.267

V1: live weight; V2: body length of total body; V3: length of exposed culmen (bill), V4: length of exposed culmen without cere; V5: windth of bill at base; V6: width of bill at gape; V7: length of head; V8: width of head; V9: heigth of eye, V10: length of closed wing, V11: length of tarsus (tarso-metatarsus); V12: length of middle toe; V13: length of hind toe (hallux), SE: standart error of mean, CV (%): coefficient of variation and for each variable, bolded P-values indicate statistically significant difference between sexes (P < 0.05).

Adult sexual size dimorphism has been reported in favor of males in poultry species, such as ostrich (Selvan et al., 2013), goose (Parés-Casanova, 2014), Muskovy duck (Oguntunji & Ayorinde, 2014), turkey (Ajayi et al., 2012), chicken, partridge (Remeš & Székely, 2010), pheasant (Mateos, 1998) and pigeon (Savaş & Erdem, 2022). However, reverse size dimorphism has been observed in blue-breasted quail (Pis & Luśnia, 2005), as in Japanese quail (Sefton & Siegel, 1974). Blue-breasted quails are monogamous, with the males offering food in their beaks to the females (tidbitting) and giving priority to feeding the females, which may explain why the beak of the male was not filed and exposed culmen was higher in cage conditions.

In current study, live weights of female blue-breasted quail were also found to be high in accordance with the previous study (Pis & Lus´nia, 2005), which did not consider any others body parameters than live weight, and females and males, at 59 days of age were found to be 61.5 g and 46.99 g, respectively. Similar to blue-breasted quail in the current study, it was reported that live weight of eight-week-old adult Japanese quail was higher in females than males, but body, wing and drumstick length were similar in both sexes (Dudusola et al., 2018). Oğrak et al. (2021) reported that body weight and body length values were higher in females, while there was no difference between sexes in terms of head length, head width, tarsus length and middle toe length in six-week-old Japanese quails, which is similar to current study. On the other hand, sexual dimorphism in favour of female have been reported for beak width in Japanese quails (Oğrak et al., 2021).

Figures 2 and 3 present the Pearson-moment correlations for female and males quails, respectively. The highest significant correlation was found between width of head and width of bill at gape in females (r = 0.477, P = 0.001) and between live weight and length of total body in males (r = 0.642 and P = 0.000). Significant positive correlations were found between live weight and length of total body, live weight and length of hind toe, length of exposed culmen and length of exposed culmen without cere, heigth of eye and length of middle toe, and heigth of eye and length of hind toe in both sex. These correlation coefficients were 0.304 (P = 0.038) and 0.642 (P = 0.000), 0.339 (P = 0.020) and 0.301 (P = 0.036), 0.384 (P = 0.008) and 0.424 (P = 0.002), 0.324 (P = 0.026) and 0.385 (P = 0.006), and 0.320 (P = 0.028) and 0.444 (P = 0.001) for females and males, respectively. Besides, significant positive correlations were determined between the length of total body and length of hind toe (r = 0.323, P = 0.027), width of bill at gape and width of head (r = 0.477, P = 0.01), and length of head and width of head (r = 0.388, P = 0.007), there were found significant negative correlations between windth of bill at base and heigth of eye (r = -0.347, P = 0.017), and width of head and length of tarsus (r = -0.443, P = 0.02) in females. In addition to these, significant positive correlations were found between live weight and heigth of eye (r = 0.405, P = 0.004), body length of total body and windth of bill at base (r = 0.485, P = 0.000), body length of total body and length of closed wing (r = 0.282, P = 0.05), length of exposed culmen without cere and length of hind toe (r = 0.326, P = 0.022), heigth of eye and length of tarsus (r = 0.325, P = 0.023), length of tarsus and length of middle toe (r = 0.372, P = 0.008), and length of middle toe and length of hind toe (r = 0.447, P = 0.001) were significant, while negative correlations were found to be insignificant in males (P > 0.05).

In a study conducted in Japanese quails, in which both sexes were evaluated together, positive correlations were reported between body weight and body measurements, and significant correlation values (P < 0.05) of 0.376, 0.599, 0.293, and 0.353 were observed between body weight and skull length, body length, middle finger length, and wing length, respectively, while correlations between body weight

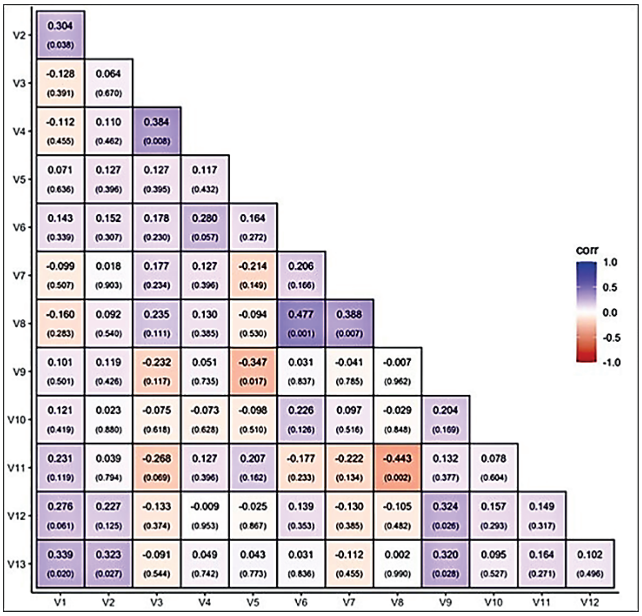

Fig. 2. Correlation coefficients for female blue-breasted quail

V1: live weight; V2: body length of total body; V3: length of exposed culmen (bill), V4: length of exposed culmen without cere; V5: windth of bill at base; V6: width of bill at gape; V7: length of head; V8: width of head; V9: heigth of eye, V10: length of closed wing, V11: length of tarsus (tarso-metatarsus); V12: length of middle toe; V13: length of hind toe (hallux) and the *P* values of the correlation coefficients are given in parentheses

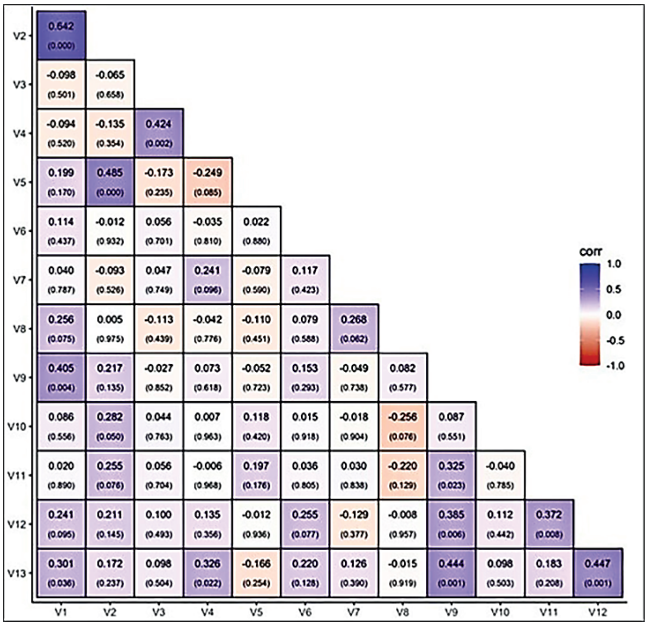

Fig. 3. Correlation coefficients for male blue-breasted quail

V1: live weight; V2: body length of total body; V3: length of exposed culmen (bill), V4: length of exposed culmen without cere; V5: windth of bill at base; V6: width of bill at gape; V7: length of head; V8: width of head; V9: heigth of eye, V10: length of closed wing, V11: length of tarsus (tarso-metatarsus); V12: length of middle toe; V13: length of hind toe (hallux) and the *P* values of the correlation coefficients are given in parentheses

and head width, beak length, beak width, and tarsus length were insignificant (Oğrak et al., 2021). According to another study conducted by Akumbugu et al. (2020), in Japanese quail, the body parameters of males and females at ten weeks of age were similar to those, used in current study, but measured from different locations. In the aforementioned study, unlike the present study, the correlation between body weight and body length was found to be significant (r = 0.465, P < 0.01) only in males, while it was found to be insignificant (r = 0.002, P > 0.05) in females. In addition, the correlations between body weight and foot length (r = 0.043, P > 0.05) in Japanese male quails were insignificant, as were the correlations in male blue-breasted quails in the present study. While the correlation between foot length and wing length in male blue-breasted quails was insignificant (r = -0.040, P = 0.785), in the present study, it was found to be negatively significant (r = 0.452, P < 0.05) in male Japanese quails (Akumbugu et al., 2020). On the other hand, the correlations between body length and foot length and wing length (r = -0.035, -0.127 and P > 0.05) and body length and wing length (r = 0.185 and P > 0.05) were found to be insignificant in female Japanese quail, whereas the correlations between foot length and body and wing length were found to be significant (r = 0.270 and P < 0.05) in female Japanese quail (Akumbugu et al., 2020) in contrast to female blue-breasted quail in the current study.

Two principal companents (PCs) with Eigen values above one accounted for 94.6 % and 78.3 % of the total variance of female and male blue-breasted quail, respectively (Table 2). In females, PC1 alone accounts for 92.3% of the total variation and was characterized by live weight (loading = 0.9982, Table 3), while the PC1 of the male accounted for 70.5% of the total variance and was again characterized by live weigt (loading = 0.9851, Table 3). The second component (PC2) explains only 2.3% and 7.8% of the total variance for females and males, respectively (Table 2). Comparable to the present results, Negash (2021) reported that the variation observed in Ethiopian indigenous chickens accounted for 45.33% and 38.27% of PC1 and 36.59% and 28.89% of PC2 in male and female birds, respectively. Likewise, the first two PCs explained 66.40% of the total variance and the effective variables were wing length, body weight and body length in Nigerian chickens (Egena et al., 2014). On the other hand, in another study of Nigerian chickens, in which eight different body measurements could be effective variables, the first three PCs accounted for 87.84, 90.60 and 89.2% of the total variance in Normal feathered, Naked neck, and Frizzled chickens, respectively (Yakubu et al., 2009). In another study, eight different body measurements were used, three PCs for Sasso and Kuroi and two PCs for Fulani birds were sufficient, and 87.36, 93.88, and 78.85% of the total variance in the three genetic groups were explained, respectively (Yakubu & Ari, 2018).

Table 2. Eigenvalues and proportion of total variance per principal components (PCs) by sex

		PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13
Female	Eigenvalue	62.336	1.564	0.950	0.758	0.611	0.508	0.251	0.182	0.131	0.097	0.083	0.044	0.037
	Proportion	0.923	0.023	0.014	0.011	0.009	0.008	0.004	0.003	0.002	0.001	0.001	0.001	0.001
	Cumulative	0.923	0.946	0.960	0.971	0.980	0.988	0.992	0.994	0.996	0.998	0.999	0.999	1.000
Male	Eigenvalue	10.075	1.109	0.863	0.586	0.443	0.314	0.244	0.222	0.161	0.101	0.073	0.061	0.032
	Proportion	0.705	0.078	0.060	0.041	0.031	0.022	0.017	0.016	0.011	0.007	0.005	0.004	0.002
	Cumulative	0.705	0.783	0.843	0.884	0.915	0.937	0.955	0.970	0.981	0.988	0.994	0.998	1.000

Table 3. Loadings and communalities for first two Principal comoponents (PCs) by sex

	Female			Male		
	PC1	PC2	Communality	PC1	PC2	Communality
V1	0.9982	0.0334	0.9976	0.9851	-0.0664	0.9749
V2	0.0152	0.0317	0.0012	0.1308	0.1489	0.0393
V3	-0.0130	0.2976	0.0887	-0.0210	0.1117	0.0129
V4	-0.0052	0.0433	0.0019	-0.0130	0.0420	0.0019
V5	0.0025	-0.0252	0.0006	0.0244	0.0489	0.0030
V6	0.0151	0.3789	0.1438	0.0239	0.0935	0.0093
V7	-0.0124	0.4980	0.2481	0.0111	-0.1302	0.0171
V8	-0.0140	0.3887	0.1513	0.0441	-0.1675	0.0300
V9	0.0049	-0.0438	0.0019	0.0424	0.1177	0.0156
V10	0.0034	0.0072	0.0001	0.0063	0.0136	0.0002
V11	0.0303	-0.5807	0.3381	0.0108	0.7794	0.6075
V12	0.0349	-0.1559	0.0255	0.0638	0.5018	0.2559
V13	0.0189	-0.0280	0.0011	0.0506	0.1726	0.0323

V1: live weight; V2: body length of total body; V3: length of exposed culmen (bill), V4: length of exposed culmen without cere; V5: windth of bill at base; V6: width of bill at gape; V7: length of head; V8: width of head; V9: heigth of eye, V10: length of closed wing, V11: length of tarsus (tarso-metatarsus); V12: length of middle toe; V13: length of hind toe (hallux)

Conclusion

Although reversed sexual dimorphism is seen for live weight, body length of total body, heigth of eye and length of closed wing, males have been found to have longer exposed culmen than females, which may be due to tidbitting behavior in males. However, some body variables (length of exposed culmen without cere, width of bill at gape, length of head, width of head) were found to be higher in males, though not statistically significant.

The results of this study show that the relationships of some body variables in blue-breasted quails vary according to gender.

In both genders, the first two principal components together explained a high percentage of the total variance. Therefore, these components can be used for the evaluation and comparison of animals.

This study is thought to be a source in terms of laying the groundwork for future studies with blue-breasted quails, which have recently been subject to different studies due to their many characteristics and have not been selective breeding yet.

Conflicts of interest

The author declares no conflict of interest.

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