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Relationships Between Morphological Characteristics of Roosters in Broiler Breeders at Different Age Periods

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Abstract

The aim of study was to determine the relationships between morphological characteristics of roosters and fertility in broiler breeders at different age periods. A total of 48 roosters and 480 hens Ross 308 broiler breeder were used. The body weight, comb width and length, wattle width and length, and tarsus length of roosters were measured for morphological characteristics at 42, and 53 weeks of age. A total of 1500 eggs were incubated at 37.7 °C and 50-55% relative humidity for 18 d, then eggs were incubated at 36.6 °C and 60% relative humidity for 3 d. The effect of age on comb length, comb index (P=0.002), wattle width (P=0.008), wattle area (P=0.015) and tarsus length were found significant (P=0.000). There were correlations between body weight and fertility at 53 weeks of age (r = 0.663; P<0.05). There was no correlation between fertility and comb length, comb width, comb area, comb index, wattle width, wattle area, wattle index, and tarsus length at 42 and 53 weeks of age (P>0.05). In conclusion; some characteristics based on external appearance are used for male selection in broiler breeders, but no relationship was found between investigated morphological characteristics and fertility, except for body weight.

Introduction

The fertility outcomes of broiler breeders are influenced by a variety of factors. Although both male and female breeders play important roles in fertility, genetic and non-genetic factors that occur in both males and females and are thought to be the most important factors influencing egg fertilization and embryo development. Especially, sperm motility, concentration, amount, and rate of abnormal and dead sperm are the main sperm characteristics that affect male fertility performance (Bansal and Cheema, 2014). In broiler breeders, roosters must be physically and behaviorally mature in order to be able to mate and successfully evoke the sexual response in females.

Fertility issues, particularly in lines descended from Cornish breeds can be brought on by an inability to mate successfully due to poor physical health and inappropriate sexual behavior (Wilson et al., 1979). Furthermore, the behavioral characteristics that allow roosters to successfully mate with chickens are dependent on the rooster's weight and leg health (Brillard, 2003). When it comes to mating behavior and optimum fertility, breeding males must be at the target body weight, should have the right leg lengths, and also should have a smooth leg structure without curled toes or abrasion problems on the sole (Anonymous, 2018). The length of the tarsus has a major influence on

fertility (Abad, 2020). Thus, tall males with a higher tarsus length may be more likely to win male-male competition, so they may have extra mating opportunities (Lei et al., 2019).

Secondary sexual characteristics in roosters are thought to play a role in increasing the frequency of mating with females. As a matter of fact, it was observed that females preferred males with large combs in case of Red Jungle Chicken (Zuk et al., 1995). If the secondary sexual characteristics of the roosters are fully developed, it indicates that they are healthier (Hamilton and Zuk, 1982), have better reproductive characteristics (Møller, 1994), and the relationship between fertility and testis weight is positive (McGary et al., 2002). Secondary sexual traits in poultry are regarded to be crucial in the selection of female mates. Comb size has been claimed to be an indicator of the amount of androgens in male's body (Verhulst et al., 1999). The exhibition of roosters has a phenotypic relationship with fertility (McGary et al., 2002), particularly during the early mating season females are attracted towards the roosters having the largest comb thus large combs may be associated to reproductive behavior in birds (Bilcik et al., 2005). It has been observed, for example, that roosters with larger combs exhibit more aggressive behavior and are more dominant against roosters with smaller combs (Bilcik et al., 2005; Mukhtar and Khan, 2012). However, in some studies; no significant link between the dimension of secondary sexual features, mating frequency, and sperm quality in predicting broiler breeder reproductive performance was reported (Wolanski et al., 2004; Bilcik et al., 2005). Roosters are often selected in breeding flocks based on characteristics such as posture, body structure, maturity, body size, leg and foot condition, head appearance, overall health and vigour. Although these traits aid in male selection, they do not guarantee a high fertility rate (Wilson et al., 1979).

In general, low-level fertility is an important problem in old aged broiler breeder flocks. Thus, this study was carried to investigate the relationships between morphological characteristics of roosters and fertility in broiler breeders at 42 and 53 weeks of age. Also, the correlations among the morphological characteristics were investigated.

Materials and Methods

This study was conducted in a private broiler breeder company. A total of 48 roosters and 480 hens Ross 308 broiler breeders were placed in a separate compartment in breeder house. The flock age was followed to obtain morphological characteristics and incubation parameters. In the house a chain type channel feeder, nipple drinker system and pine sawdust litter were used. The broiler breeders were fed with a standard broiler breeder feed containing (14.5% CP and 2750 ME) and water provided was ad libitum. The 13L: 11D light duration and 60 lux light intensity were applied according to broiler breeder standards.

All roosters© morphological characteristics such as; body weight, comb width and length, wattle width and length, and tarsus length were measured at 42 WOA (weeks of age), and then again measured at 53 WOA. The body weight of the roosters recorded by weighing 0.1 g with a precision balance then comb, wattle and tarsus measurements were taken from the same roosters. The comb area and wattle area were calculated according to Chung (2010); for this, the length and width of the comb, the length and width of the wattle were measured with a digital caliper from the left side of the roosters. The comb and wattle index were calculated according to Francesh et al. (2011). The length of the left tarsus bone was determined by measuring the distance between the knee joint and the sole of the foot with a digital caliper (Souza et al., 2017). The formulas used in the calculation of morphological characteristics are given below.

$$\text{Comb area} = \text{comb width} \times \text{comb height}$$
$$\text{Wattle area} = \text{wattle width} \times \text{wattle height}$$
$$\text{Comb index} = (\text{comb length}) / (\text{comb width})$$
$$\text{Wattle index} = (\text{wattle length}) / (\text{wattle width})$$

Eggs were obtained from separated experimental compartment at 42 WOA, then again obtained at 53 WOA. A total of 1500 eggs were incubated at each age period for fertility results. Eggs were stored at 18 ℃ temperature and 70-75% relative humidity (RH) for 5-7 d. Each tray in the incubator held 150 eggs, with 10 trays being used for each age. Eggs pre-warmed before incubation at 24 ℃ and 70-75% RH during 8 hours. Eggs were incubated in the setter at 37.7 ℃ and 50-55% RH for 18 d. Eggs were incubated in the hatcher at 36.6 ℃ and 60% RH for 3 d. At hatch chicks were counted and all unhatched eggs were examined for fertility and embryonic mortality. Then fertility was calculated.

The data were analyzed by using two sample T-test using the Minitab software (Minitab, 2013). After arcsine transformation, the percentage data analyses were carried out. The correlations between morphological characteristics and fertility were analyzed with Pearson correlation analysis (Minitab, 2013). Differences were considered significant at $P \leq 0.05$ and the statistical difference at $P < 0.10$ was described as a tendency.

Results and Discussion

The morphological characteristic of roosters and fertility in broiler breeders at 42 and 53 WOA are given in Table 1. In the study, the effect of age on

Table 1. The morphological characteristics of roosters and fertility in broiler breeders at different age (mean ± StDev)

Characteristics	42 WOA	53 WOA	P
Body weight, g	4693.9 ± 314	4737.5 ± 236	0.454
Comb length, mm	128.8 ± 9.74[b]	135.5 ± 7.35[a]	0.000
Comb width, mm	73.6 ± 7.42	73.1 ± 7.17	0.737
Comb area, mm^2	9535 ± 1618	9913 ± 1226	0.212
Comb index	1.76 ± 0.12[b]	1.87 ± 0.19[a]	0.002
Wattle length, mm	54.5 ± 5.91	52.3 ± 5.03	0.056
Wattle width, mm	54.9 ± 5.73[a]	52.1 ± 4.29[b]	0.008
Wattle area, mm^2	3030.9 ± 639[a]	2742.3 ± 462[b]	0.015
Wattle index	0.99 ± 0.03	1.00 ± 0.06	0.239
Tarsus length, mm	122.4 ± 6.57[a]	116.9 ± 3.89[b]	0.000
Fertility, %	96.07 ± 2.30	94.27 ± 2.27	0.096

[a,b]; Differences between means with different letters in the same column are significant (P<0.05). WOA: Weeks of age

comb length (P=0.000), comb index (P=0.002), wattle width (P=0.008), wattle area (P=0.015) and tarsus length were significant (P=0.000). But, effect of age on wattle length and fertility tend to be significant (P=0.056 and P=0.096; respectively). The effect of age on body weight, comb width, comb area, wattle index was not found significant (P>0.05).

The body weight is highly heritable and simple to determine (Groeneveld et al., 2010). Bird growth rates vary depending on age and species. In the study, body weight was not affected by age, but body weight at 53 WOA was numerically higher than 42 WOA. It was to be expected thus body weight is a trait affected by age (Hocking and Bernard, 1997). The results are in accordance with the Leão et al. (2017) who showed that body weight increased with age (25 to 45 weeks of age) in male broiler breeders. Meanwhile, Özdemir (2019) reported that an increase in bodyweight with age in both İspenç genotype roosters and chickens.

Along with the increase in age, comb length and comb index were increased. But the other comb characteristics such as, comb width and comb area were found similar in investigated age periods. However, Leão et al. (2017) revealed that there was no difference for histological comb score between the 25 and 45 WOA groups.

Along with the increase in age wattle width and wattle area decreased and, also wattle length tended to be lower at 53 WOA than in 42 WOA. But wattle index was found similar in investigated age periods. However, Nääs et al. (2008) reported that there was an increase in wattle width with increasing age in male broilers of Cobb 500. They also reported that there was no significant morphological difference found at 28 day of age, but at 35 and 48 day of age a difference in wattle width was found when compared to the other morphological characteristics. Also, Özdemir (2019) reported that a significant increase in wattle length, width and comb length, width, with the increased age in İspenç genotype roosters.

The tarsus length was found lower at 53 WOA than 42 WOA, and tarsus length was decreased with the increased age. A slight decrease in tarsus length was found at 53 WOA, it might be result of body weight getting heavier and deformation in the bones with age. But, Özdemir (2019) reported that there was no difference between tarsus lengths of İspenç roosters (small genotype) at different age periods.

In the study, fertility tend to be decreased with increased age. This finding in accordance with Yılmaz Dikmen and Şahan (2009) who reported that fertility rate decreased with increased age in broiler breeder. The decrease in fertility with increased age was also reported by some authors (Gumułka and Kapkowska, 2005; Abudabos, 2010; Mahammad et al., 2018).

The correlations between morphological characteristics of roosters and fertility in broiler breeders at different age are shown in Table 2. In the study, correlation between body weight and comb width (r = 0.265; P= 0.068) was found tend to be significant at 42 WOA, but there was no correlation between body weight and investigated comb characteristics at 53 WOA (P>0.05). According to these findings, there might be a slight relationship between body weight and comb characteristics at 42 WOA. Also negative correlations between body weight and comb index (r = -0.281; P=0.053) was found tend to be significant at 42 WOA. Kumar et al. (2022) in a study carried on Aseel and Kadaknath chickens at 24 week of age reported a correlation between body weight and comb length. Almost similar study was carried by Leão et al. (2017) that showed positive significant correlation between histological comb score and live weight. Also, Rizzi and Verdiglione (2015) reported that there was a correlation between comb and wattles weight and body weight in Italian purebreds of Robusta lionata. There were no significant correlations found between body weight and all investigated wattle characteristics, also tarsus length in investigated age periods (P>0.05). In a study, Dahloum et al. (2016) showed males having stronger

Table 2. Correlations between morphological traits of roosters and fertility in broiler breeders at different age

	WOA	CL	CW	CA	CI	WL	WW	WA	WI	TL	F
BW	42	0.131^{NS}	0.265$^{0.068}$	0.212^{NS}	-0.281$^{0.053}$	-0.049^{NS}	-0.099^{NS}	-0.062^{NS}	0.195^{NS}	-0.009^{NS}	0.097^{NS}
	53	0.242^{NS}	0.038^{NS}	0.136^{NS}	0.111^{NS}	0.125^{NS}	0.087^{NS}	0.107^{NS}	0.091^{NS}	0.018^{NS}	0.663*
CL	42		0.769****	0.926****	-0.040^{NS}	0.091^{NS}	0.077^{NS}	0.092^{NS}	0.076^{NS}	-0.211^{NS}	0.226^{NS}
	53		0.176^{NS}	0.603****	0.365*	0.542****	0.513***	0.571****	0.156^{NS}	0.102^{NS}	0.234^{NS}
CW	42			0.951****	-0.667****	0.091^{NS}	0.063^{NS}	0.081^{NS}	0.123^{NS}	-0.145^{NS}	0.038^{NS}
	53			0.890****	-0.848****	0.362*	0.213^{NS}	0.323*	0.288$^{0.065}$	-0.003^{NS}	-0.015^{NS}
CA	42				-0.409**	0.103^{NS}	0.078^{NS}	0.097^{NS}	0.116^{NS}	-0.174^{NS}	0.149^{NS}
	53				-0.518****	0.556****	0.405**	0.531****	0.329*	0.043^{NS}	0.103^{NS}
CI	42					-0.031^{NS}	-0.007^{NS}	-0.015^{NS}	-0.094^{NS}	-0.008^{NS}	0.194^{NS}
	53					-0.070^{NS}	0.042^{NS}	-0.027^{NS}	-0.173^{NS}	0.047^{NS}	0.288^{NS}
WL	42						0.972****	0.992****	0.268$^{0.065}$	0.339**	0.131^{NS}
	53						0.760****	0.943****	0.542 ****	0.049^{NS}	0.178^{NS}
WW	42							0.989****	0.034^{NS}	0.308*	0.160^{NS}
	53							0.928****	-0.133^{NS}	-0.008^{NS}	0.254^{NS}
WA	42								0.162^{NS}	0.310*	0.158^{NS}
	53								0.238^{NS}	0.043^{NS}	0.217^{NS}
WI	42									0.179^{NS}	-0.215^{NS}
	53									0.080^{NS}	-0.406^{NS}
TL	42										0.192^{NS}
	53										0.103^{NS}

Correlation coefficient values (r). *: P<0.05; **: P<0.01; ***: P<0.001; ****: P< 0.0001, NS: Not significant
WOA: Weeks of age; BW: Body weight, CL: Comb length, CW: Comb width, CA: Comb area, CI: Comb index,
WL: Wattle length, WW: Wattle width, WA: Wattle area, WI: Wattle index, TL: Tarsus length, F: Fertility

correlations between body length and either body weight, tarsus length, or comb height than females' indigenous chicken genotype. In both the Hubbard and Arboracre strains, a study by Yahaya et al. (2012) revealed a strong linear relationship between body weight and tarsus length. Another study conducted by Abdel-Latiff (2019) found that in White leghorn chickens, there was a highly significant correlation between body weight and shank length and also correlation with shank diameter. Also positive correlation between body weight and tarsus length was reported by Adeogun and Adeoye (2004). In the study, there was moderate positive correlation between body weight and fertility at 53 WOA ($r = 0.663$; $P<0.05$).

In the study correlations between comb length and comb width, comb area at 42 WOA ($r = 0.769$, $P<0.0001$; $r = 0.926$, $P<0.0001$); and comb area, comb index, wattle length, wattle width, wattle area at 53 WOA ($r = 0.603$, $P<0.0001$; $r = 0.365$, $P<0.05$; $r = 0.542$, $P<0.0001$; $r = 0.513$, $P<0.001$; $r = 0.571$, $P<0.0001$) found significant. Females preferred larger-combed roosters, especially during the initial mating season. Thus, males who attempted mating more frequently had larger combs (Bilcik et al., 2005). There were positive correlations between comb length and comb width, comb area at 42 WOA ($P<0.0001$). Thus, Joseph et al. (2003) reported that a significant correlation between comb height, length, area; and also significant correlation between investigated comb traits and age in female broiler breeders. There were positive correlations between comb length and comb area; comb index at 53 WOA ($P<0.0001$ and $P<0.05$). However, there were negative correlations between comb width and comb index ($P<0.0001$), comb area and comb index ($P<0.01$ and $P<0.0001$) at all investigated age periods.

The comb and wattle size are related to gonadal development and sex hormone secretion (Nesheim et al., 1979). According to Tabbaa and Hassanin (2018) a numerical difference in comb size frequencies among different breeds was observed however no significant difference was noticed. In the study, there were positive correlations between comb length and wattle length, width, area ($P<0.0001$; $P<0.001$; $P<0.0001$); also, there were positive correlations between comb width and wattle length, wattle area at 53 WOA ($P<0.05$). According to these findings, it could be said that comb characteristics and wattle characteristics were positively related to each other in broiler breeder roosters. However, there were no correlations between investigated comb characteristics and tarsus length in all investigated age periods ($P>0.05$). Rizzi and Verdiglione (2015) measured comb and wattle weights of male chickens from three different Italian purebreds (*Robusta maculate*, *Ermellinata di Rovigo* and *Robusta lionata*), the comb and wattle weight were significantly correlated in all purebreeds.

It has been observed, that roosters with larger combs exhibit more aggressive behavior and more dominant against roosters with smaller combs (Bilcik et al., 2005; Mukhtar and Khan, 2012). In the study, there were no significant correlation between investigated comb characteristics and fertility in investigated all age periods ($P>0.05$). Thus, Pizzari et al. (2004) reported that there was no relation between comb size and sperm quality in cross breeds of domestic fowl and red jungle fowl.

In the study there were positive correlations found between wattle length and wattle width, area; also, there were positive correlations between wattle width and wattle area in investigated all age periods ($P<0.0001$). It might be a result of investigated wattle characteristics were positively related to each other. There was no correlation between wattle width and wattle index; no correlation between wattle area and wattle index in investigated all age periods ($P>0.05$). The correlation between wattle length and wattle index was tend to be significant at 42 WOA ($P= 0.065$). The significant positive correlations were found between wattle width and wattle area at all investigated age periods ($P<0.0001$).

There were positive correlations between wattle length, width, area and tarsus length at 42 WOA ($P<0.01$, $P<0.05$, $P<0.05$; respectively). According to these findings, it could be said that some wattle characteristics such as; length, width, and tarsus length were positively related to each other in broiler breeder roosters. In the study, there were no correlation between investigated wattle characteristics and fertility in all investigated age periods ($P>0.05$). Similar to our findings Bilcik and Estevez (2005) reported that there was no correlation between wattle width and fertility in broiler breeders. However, McGary et al. (2003) reported that comb width, wattle length was positively related with sperm penetration and also fertility in male broiler breeder. Also, in the study, there were no correlation between tarsus length and fertility in all investigated age periods ($P>0.05$). These findings accordance with McGary et al. (2003) who measured that the leg and pelvic fluctuating asymmetry of male broiler breeder, and reported that there were no correlations between these traits and fertility or sperm penetration. Also, Yılmaz Dikmen and İpek (2006) reported that shank length had no discernible impact on fertility or hatchability in Japanese quails.

Conclusion

In conclusion morphological characteristics such as; comb length, index, wattle length, width, area and tarsus length were affected by breeder age. Although

some characteristics based on external appearance are used for male selection in broiler breeders, but no relationship was found between investigated morphological characteristics and fertility, except for body weight.

Highlights

The body weight, comb width and length, wattle width and length, and tarsus length of roosters were measured for morphological characteristics at 42, and then 53 weeks of age.

A total of 1500 eggs were incubated for fertility results at 42, and then 53 weeks of age.

Although some characteristics based on external appearance are used for male selection in broiler breeders, but no relationship was found between investigated morphological characteristics and fertility, except for body weight.

Ethical Statement

This study was approved by the Bursa Uludağ University Animal Experiments Local Ethics Committee (Approval no: 2019-12/06).

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