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Research Article

ROOSTER PHENOTYPIC TRAITS INFLUENCE ON THE REPRODUCTIVE PERFORMANCE OF THE BROILER PARENTS

***Mozafar Rahimpoor, Heshmatollah Khosravinia and Majid Khaldari**
Department of Animal Science, Lorestan University, P.O. Box 14515-4933, Lorestan, Iran
**Author for Correspondence*

ABSTRACT

In this research influence of the rooster phenotypic traits on reproductive performance of broiler parents was examined for PB2 hybrids. 111 broiler breeder males were individually housed with an average of 10 females per male. During 30^{th} up to 51^{th} week of age, BW, comb length and width (CL, CW), wattle length and width (WL, WW) and shank length and width (SL, SW) were measured. Results showed that between rooster body weight, comb length and wattle length there were positive statistically significant correlation. This research provides evidence that morphometric traits might be useful to predict reproductive performance in broiler breeders.

Keywords**:** *Rooster Phenotypic Traits, Reproductive Performance, Broiler Parents*

INTRODUCTION

The recent decline of fertility of naturally mated broiler breeder flocks (Reddy and Sajadi, 1990) is related, in part, to the differential reproduction among males, as some males have high fertility whereas others have low fertility (subfertile) and, hence, contribute to a reduction in overall flock fertility. Although male broiler breeder behavior (Burke and Mauldin, 1985; Jones and Mench, 1991) and physiology (Wishart and Palmer, 1986; Froman *et al*., 1992) affect the level of fertility attained by individuals, male physical characteristics may also are important. Male broiler breeders must be physiologically and behaviorally mature to successfully elicit the female sexual response and copulate. Fertility problems, particularly those associated with Cornish-derived lines, may result from a physical inability to successfully copulate or from the absence of sexual behavior (Wilson *et al*., 1979).

Genetic selection focuses on increasing growth rate, body weight, and yield; yet traits related to reproduction may be inadvertently altered in the process. Phenotypic modifications, such as altered secondary sexual characters or reduced libido, may accompany selection for traits of economic importance. For example, comb and wattle growth are androgen dependent (Zeller, 1971) and have been shown to correlate with a male's health status in red jungle fowl (Hamilton and Zuk, 1982). Sexual selection theory states that this differential expression (individual variation in the degree of phenotypic expression) of secondary sexual characters may reliably indicate individual male quality (Hamilton and Zuk, 1982; Andersson, 1994). Evidence provided by Zuk *et al.*, (1995) supports this theory, as when female red jungle fowl were given a choice of two males during a preference test, they more frequently mated with males possessing large combs.

These modifications may negatively impact male mating ability, possibly resulting in lower fertility. An additional consequence of selection for growth is that skeletal conformation and leg dimensions have likely been modified to physically support birds' bodies. These physical modifications may impede semen transfer (Soller *et al*., 1965; Wilson *et al*., 1979; Hocking and Duff, 1989; Siegel and Dunnington, 1985), for example, through altered compatibility of the male and female cloacal positioning during copulation, which could reduce concomitant fertility.

The intent of this study was to characterize the relationship between various physical traits and reproductive performance in broiler breeders.

MATERIALS AND METHODS

Experimental Design

In the present research, one parental flock of heavy hybrids PB2 was taken. During the production technology recommended by selection office was used. Broiler parents were kept on the floor with deep bedding, diet; watering, airing and illumination were automatically controlled. Effective floor surface of facility was approximately 150 m^2, where density of population was approximately 6 birds/m^2 of floor surface.

Researched broiler parent flock was bred from 21st week till 51st week of age. Eggs that were laid from the 30th week and till the 51st week of the production cycle were used for incubation. This shows that period of egg production (production of day old broiler chicks) lasted 21 weeks (from 30th till 51st week of age of broiler parents).

As starting experimental material total number of 888 birds of broiler parents, bred facility was used. Facility was populated with 777 ♀ and 111 ♂ so that gender ratio was 1:7.

In preparation period from 21st till 24th week of age mortality and elimination for roosters was 4 units (0.89%). This means that at the beginning of the use of incubation eggs, broiler parents had 107 roosters.

In order to control the body weight, every week body weight of 10 roosters was individually taken using random sample method.

By this inspection uniformity of roosters of researched flock during production cycle and the influence of rooster body weight on reproductive indicators of broiler parents was tested.

Data were collected across the following ages: Period 1 (30 to 33 wk), Period 2 (34 to 37 wk), Period 3 (38 to 41 wk), Period 4 (43 to 46 wk), and Period 5 (48 to 51 wk). At each period, fertility was determined for each experimental male. CL, CW, WL, WW, WA, SL and SW were measured at early and late age periods, and live body weights was measured during all Periods. The experimental protocol was approved by the Lorestan University Animal Care and Use Committee.

Fertility through the Perivitelline Layer

Fertility was estimated by macroscopic assessment of the germinal disc (Bakst *et al*., 1997; Hazary *et al*., 2001) of four fresh-laid eggs collected from each experimental pen at each age period. During each farm visit at each age period, we took a random sample of four eggs per pen on a single afternoon to ensure that each egg represented a different female within each pen. Because the males were housed in individual pens, this allowed us to estimate percentage fertility for individual males. Eggs were stored at 13 ºC and 75% relative humidity and were evaluated within 5 d of collection.

Estimated fertility (%) was calculated for individual males at each age period. It should be mentioned that McGary *et al.,* (2002) demonstrated that this method of fertility estimation (based on the four egg sample) strongly correlated with candling fertility, estimated from collections of all laid eggs during a full week for each age period.

Physical Measurements

Wattle length (WL) and width (WW), comb length (CL) and width (CW), Shank length (SL) and width (SW) were measured for each male by PC image analysis (Scion Corporation, Frederick, MD 21701) of digital pictures of the left and right sides of the head. Each picture includes a metric ruler for calibration. The computer mouse was used to trace WL, WW, WA, CL, CW, SL and SW and the distance (mm) or area (mm^2) was calculated by the Scion Image Analysis Software.

The WL and CL were measured as the maximum horizontal distance between the front and the rear of the comb/wattle. The CW was measured as the maximum vertical distance from the highest peak of the comb to the base and WW as the maximum vertical distance from base of the wattle to the distal end. Tracing the perimeter of the wattle with the computer mouse allowed Scion software to calculate WA.

The WW, WA, CL, and CW per male for the early and late age periods were determined. Because trait size did not differ between ages ($P > 0.05$), the mean trait size between these two measurements was calculated and used for subsequent statistical analyses.

Statistical Analyses

Basic data processing was conducted using usual variation – statistical methods, and testing of the differences between hybrids was done using the T- test. For all monitored indicators average value, random sampling error and standard deviation were calculated.

Determined results were used to calculate the correlation of researched indicators per week of production by using the correlation analysis. Statistical data processing was done using Analyst Program SAS/STAT (SAS Institute, 2000).

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RESULTS AND DISCUSION

Table 1: Live Performance Traits of the Roosters in Specific Periods of the Production Cycle

	Weeks of Age (Production)						
Live Performance Traits	30 (6)	34 (10)	38 (14)	43 (19)	48 (24)	Mean±SE	SE
Average Body Weight (Kg)	4.00	4.15	4.24	4.33	4.54	4.252	.0400
Fertility (%)	89.51	89.70	89.86	90.59	88.59	89.65	.4100
Hatchability (%)	78.70	80.80	82.20	82.90	82.20	81.36	.7800
Shank Length (cm)	7.60	7.90	8.40	8.70	9.20	8.36	.6000
Shank Width (cm)	2.20	2.40	2.40	2.50	2.60	2.42	.2000
Comb Length (cm)	4.70	5.00	5.40	5.70	6.10	5.38	.5000
Comb Width (cm)	0.50	0.50	0.60	0.65	0.70	0.59	.0100
Wattle Length (cm)	4.90	5.30	5.60	6.00	6.30	5.62	.5000
Wattle Width (cm)	0.40	0.40	0.50	0.50	0.60	0.48	.0100

Table 2: Pearson Correlation Coefficient between Roosters Phenotype Traits and Reproduction Performance from 30 up to 51 Week of Age

Variable	**Weight**	**Fertility**	**Hatchability**	**Shank length**	**Shank width**	**Wattle length**	**Wattle width**	**Comb length**	**Comb width**
Weight	1	**0.508**	**0.689**	-0.141	-0.187	-0.005	-0.009	0.331	0.285
Fertility		1	**0.769**	0.06	0.02	**0.346**	**0.315**	**0.305**	**0.296**
Hatchability			1	0.09	0.09	**0.378**	**0.350**	**0.368**	**0.357**
Shank length				1	**0.540**	0.137	0.058	-0.250	-0.099
Shank width					1	0.098	-0.023	-0.190	-0.009
Wattle length						1	**0.480**	0.059	0.140
Wattle width							1	0.101	0.097
Comb length								1	**0.300**
Comb width									1

Values in bold are different from 0 with a significance level alpha = 0.05.

Results

Live performance traits of the roosters from 30th week up to 51th week of age in the production cycle are displayed in table 1. In order to analyze parent flocks, next to determined rooster body weight, with aim to have better overview of physical traits influence on reproductive performance, phenotype correlation coefficients between monitored indicators were calculated (table 2).

From 30th week up to 50th week of age for parental flocks, statistically positive correlation coefficient was determined between body weight, fertility and hatchability (table 2). Based on results, it can be noted that rooster body weight had significantly positive influence on laying fertility and hatchability up to 50th week of age (P < 0.05). Males with greater WL and WW tended to have higher fertility and hatchability (P < 0.05). The same relationship was found for CL and CW as well, which correlated with fertility and hatchability (P < 0.05).

Discussion

The goal of the current experiment was to characterize the relationships between roosters physical traits and reproduction performance of broiler breeders. The focus was on male fertility, because with single-sire pedigree pens, male reproductive failure results in a reduced contribution to regeneration from that male (Pollock, 1999).

Djermanovic (2010 and 2013) had similar results regarding the rooster body weight influence on reproductive traits in his research of the reproductive performances of two broiler parent flocks (Ross 308 and Cobb 500). He found strong positive correlation between body weight, fertility and hatchability from 41^{th} up to 51^{th} week of age, the age we studied in this experiment, and for the rest of the production cycle (51 to 61) correlation decreased and became negative for three end weeks. McGary *et al.,* (2002) had similar results with two different strains of different age (strain A – 50 weeks and strain B – 48 weeks). Also, Bowling (2003) found negative correlation (r = -0.23) between body weight of young (35 – 45 weeks) and older (50 – 65 weeks) roosters and fertility, whereas Wilson *et al.,* (1979) determined weak correlation (r = -0.39 do r = 0.09). In the contrary of the above stated, Renden and Pirson (1982) and Bramvell *et al.,* (1996) determined that there is no difference in fertility of the young (39 weeks) and old (65 weeks) roosters.

We investigated comb, wattle and shank size as potential phenotypic fertility correlates.

Fertility problems were unlikely due exclusively to female impact upon postcopulatory sperm storage and motility, due to the fact that four eggs per pen were sampled at each age period to account for potential female effects. It appears that fertility can be accurately estimated by GD assessment of a sample of fresh-laid eggs, which is quicker and less labor-intensive than candling at Day19 of incubation. Fertility values in this study increased from 30^{th} week of age up to 43^{th} week of age and then started to decrease in 48^{th} week.

It seems that fertility and hatchability pass the same trend, as was reported by Macgary *et al*., (2002). Relationships between phenotype and fertility and hatchability may provide reliable indicator traits to facilitate the identification and removal of subfertile males from the breeder flock.

WL, WW, CL and CW positively correlated with fertility and hatchability, providing further evidence of the relationships between differential phenotypic expression of secondary sexual traits and an individual's reproductive success, in agreement with the results reported by McGary *et al*., (2002) for comb area. These findings therefore reinforce the potential use of secondary sexual characters as reliable fertility indicators within at least some genetic strains of broiler breeders. In general, heritability for traits related to fertility tends to be low (Chambers, 1990; Gowe *et al*., 1993; Leeson and Summers, 2000). Selection pressure for comb and Wattle size had the potential to improve fertility of broiler breeders in this study, although it should be investigated further before routine application to genetic selection regimes. These positive correlations suggest that males with larger combs and wattles are more fertile than small-combed and small-wattled males, which is in agreement with Zuk *et al.,* (1990a, b), who found that male red jungle fowl with larger combs were preferred by females and had greater reproductive success.

Conclusion

In conclusion, the present study provides further evidence suggesting the potential for secondary sexual characters, namely CL, CW, WL and WW, to indicate male fertility levels in some genetic strains of broiler breeders. So that, the positive correlation between WL, CL, fertility and hatchability in indicate that the development of secondary sexual characters may convey male reproductive quality. Because of the discrepancy of results between this study and other studies, we suggest that independent strain evaluation must be conducted to characterize the most reliable phenotypic fertility indicators in each case.

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