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EVALUATION OF EFFECTS OF A STRAIN, STOCKING DENSITY AND AGE ON BILATERAL SYMMETRY OF BROILER CHICKENS

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ABSTRACT

The study was conducted to assess bilateral symmetry of broiler chicken strains raised on different stocking densities. The study lasted for eight weeks with 216 broiler chickens belonging to three different strains used for the experiment: Marshal, Ross 308 and Arbor Acres. The birds were randomly allotted to three different stocking densities of 10, 12 and 14 birds.m^{-2}, respectively. Each treatment was replicated twice in a 2 ×3 factorial design. Left and right leg length, wing length and face length of the same birds from each group were measured weekly from 35th to 56th days of age using a digital caliper. The morphological data collected on the birds were used to estimate bilateral symmetries. Data were subjected to analysis of variance (ANOVA) using a Statistical Analysis System, SAS (2004). The results showed that effect of strains on bilateral symmetry of face length of the broiler chickens was not significant ($p > 0.05$). The bilateral symmetry of the wing length was significantly affected by a strain of the broiler chickens. The results showed that effect of stocking density on bilateral symmetry of face length of the broiler chicken was not significant. The bilateral symmetry of wing length was significantly affected by the stocking density of the chicken. There was a significant effect of age on bilateral symmetry of face length of the chicken. There were significant interaction effects of strain and stocking density on bilateral symmetry of broiler chickens. Based on results of the study it is concluded that the bilateral symmetry of morphological traits, as estimated by directional asymmetry, fluctuating asymmetry and relative asymmetry, were affected by a strain of the chicken and stocking density. Thus, the strain and stocking density may be claimed as important factors affecting developmental stability of broiler chickens.

Key words: bilateral density; stocking; strain; symmetry

INTRODUCTION

Broiler chickens (*Gallus gallus domesticus*) are a gallinaceous domesticated fowl bred raised specifically for meat production. They are usually raised as mixed--sex flocks in large sheds under intensive condition, but some strains can be raised as free-range flock. Most commercial broilers reach slaughter weight at five to seven weeks of age, although slower growing strains reach slaughter weight at approximately 14 weeks of age (Kruchten, 2002). There are different strains of broilers which include Arbor Acres, Anak 2000, Marshal, Ross and Hubbard. Arbor Acres, Marshal and Ross were among the strains of broiler chicken reared by farmers in Nigeria. They cope fairly well with the hot season of January to March in Nigeria and reach market weight at about 8 weeks of age (Udeh and Ogbu, 2011). In broiler production, a stocking density (floor space per chicken) is very important welfare factor, minimal standard in relation to welfare of broilers are focused on space for their walking, which is the main prerequisite for development of locomotive apparatus and demonstration of basic forms of behavior (Skubic *et al.*, 2007).

Fast growing broiler chickens have a large appetite and high body weight gain in short time. This large appetite and some other environmental conditions together may cause problems such as flip-over syndrome, left-right side differences of bilateral traits and some other health problems (Mendes *et al.*, 2007). The situation where the right and left sides of the animals are not grown at equal levels or do not display a similar growth are seen often. This is a situation which depends on genetic structures,

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rearing and the other environmental conditions of animals (Campo *et al*., 2005). Bilateral symmetry, the deviation of a part of an organism from perfect symmetry can be categorized as anti-symmetry, directional, or fluctuating (Van Valen, 1962; Mirtagioglu *et al*., 2013). It is an undeniable fact that the performances of symmetric animals are higher than those which are not symmetric (Manning and Ockenden, 1994). Thus, this study sought to assess the bilateral symmetry of broiler chicken raised at different stocking densities.

MATERIAL AND METHODS

The study was conducted in a commercial poultry farm in Ibadan, Nigeria. The dimension of each pen was 2.01 m^2 (2.01 m x 1.00 m) and it was constructed in a way as to permit straight-through ventilation. The birds were fed commercial broiler feed ration (2900 kcal.kg ME^{-1} and 20.00 % crude protein). Fresh feed and clean water were supplied *ad libitum*. The feeders and drinkers were served proportionally depending on the number of birds per treatment. Vaccination schedule and other management practices were strictly kept. The study lasted for eight weeks. Totally 216 day-old broiler chicks, consisting of three different strains, were used for the experiment: Marshal, Ross 308 and Arbor Acres. The birds were randomly allotted to three different stocking densities: 10, 12 and 14 $birds.m^{-2}$ respectively. Each treatment was replicated twice in a 2×3 factorial design.

Data collection

Left and right leg length, wing length and face length of the same birds from each group were measured weekly from 35^{th} to 56^{th} days of age (after breeding the chicks for four weeks) using a digital caliper. The morphological data collected on the birds were used to estimate bilateral symmetries as early described (Yalcin *et al*., 2003; Mendes, 2008; Mirtagioglu *et al*., 2013). Directional asymmetry (DA), fluctuating asymmetry (FA), anti-symmetry (AS) and relative asymmetry (RA) were used as measures for deviation from bilateral symmetry. DA was defined as mean not zero with normal distribution. Therefore, DA is an asymmetry in which growth on a given side consistently exceeds that on the other side. AS was defined as mean zero with non-normal distribution and FA was defined as mean zero with normal distribution based on absolute differences between left and right sides (L-R). FA is one of the measures of developmental instability of quantitative properties resulting from errors in developmental processes. Therefore, the FA can be defined as the asymmetry due to chance fluctuation in the development of the left and right sides of body. RA was defined as the ratio of the absolute value of left-right differences divided by the value for the size of the trait.

Statistical analysis

Data were subjected to analysis of variance (ANOVA) using statistical analysis System, SAS (2004), where statistical differences occurred, the means were separated using Duncan Multiple Range Test (DMRT).

Table 1: Effects of strains on bilateral symmetry of broiler chickens (mean ± SD) (mm)

Strains	Bilateral symmetry	Face length	Wing length	Leg length
Arbor Acres	Fluctuating asymmetry	0.12 ± 0.02	0.37 ± 0.05^{ab}	0.04 ± 0.03
	Anti – Symmetry (FA)	0.12 ± 0.02	0.37 ± 0.50^{ab}	0.04 ± 0.03
	Relative asymmetry	3.65 ± 0.65	2.10 ± 0.29^{ab}	0.02 ± 0.01
	Directional asymmetry	3.40 ± 0.03	17.73 ± 0.10^{b}	$272.48 \pm .34^{b}$
Marshal	Fluctuating asymmetry	0.12 ± 0.02	0.28 ± 0.05^{b}	0.06 ± 0.02
	Anti – Symmetry (FA)	0.12 ± 0.02	0.28 ± 0.05^{b}	0.06 ± 0.02
	Relative asymmetry	3.41 ± 0.48	1.50 ± 0.30^{b}	0.02 ± 0.01
	Directional asymmetry	3.37 ± 0.03	18.13 ± 010^{a}	276.56 ± 2.73^{ab}
Ross	Fluctuating asymmetry	0.13 ± 0.01	0.48 ± 0.04^{a}	0.02 ± 0.03
	Anti – Symmetry (FA)	0.13 ± 0.01	0.48 ± 0.04^{a}	0.02 ± 0.03
	Relative asymmetry	3.78 ± 0.44	2.71 ± 0.24^{a}	0.01 ± 0.01
	Directional asymmetry	3.38 ± 0.02	17.85 ± 0.11^{ab}	283.43 ± 200^{a}

$^{a, b}$ means of different superscripts along the same column are significantly different ($p < 0.05$); SD – Standard deviation

RESULTS AND DISCUSSION

Table 1 shows the effect of strains on bilateral symmetry of the broiler chickens. The results showed that effect of strains on bilateral symmetry of face length of the broiler chickens was not significant ($p > 0.05$). The bilateral symmetry of the wing length was significantly affected by the strain of the broiler chicken ($p < 0.05$). Ross chicken had the highest FA for wing length. This implies that the Ross strain has large deviation from perfect symmetry (bilaterally asymmetrical). Palmer and Strobeck (1992) reported that FA was the highly

Table 2: Effects of stocking densities on bilateral symmetry of broiler chicken (mean ± SD) (mm)

Stocking densities	Bilateral symmetry	Face length	Wing length	Leg length
10 bird.m^{-2}	Fluctuating asymmetry	0.12 ± 0.02	0.47 ± 0.04^{a}	0.03 ± 0.04
	Anti – Symmetry (FA)	0.12 ± 0.02	0.47 ± 0.04^{a}	0.03 ± 0.04
	Relative asymmetry	3.26 ± 0.47	2.63 ± 0.24^{a}	0.01 ± 0.02
	Directional asymmetry	3.39 ± 0.03	18.08 ± 0.9^{a}	274.96 ± 2.66^{b}
12 bird.m^{-2}	Fluctuating asymmetry	0.11 ± 0.02	0.27 ± 0.05^{b}	0.03 ± 0.02
	Anti – Symmetry (FA)	0.11 ± 0.02	0.27 ± 0.05^{b}	0.03 ± 0.02
	Relative asymmetry	3.42 ± 0.62	1.49 ± 0.28^{b}	0.01 ± 0.01
	Directional asymmetry	3.36 ± 0.02	17.96 ± 0.11^{b}	281.11 ± 2.32^{a}
14 bird.m^{-2}	Fluctuating asymmetry	0.11 ± 0.02	0.38 ± 0.05^{ab}	0.05 ± 0.01
	Anti – Symmetry (FA)	0.11 ± 0.02	0.38 ± 0.05^{ab}	0.05 ± 0.11
	Relative asymmetry	3.34 ± 0.57	2.19 ± 0.30^{ab}	0.02 ± 0.01
	Directional asymmetry	3.40 ± 0.03	17.87 ± 0.11^{b}	276.42 ± 3.24^{b}

[a, b] means of different superscripts along the same column are significantly different ($p < 0.05$); SD – Standard deviation

Table 3: Effects of age on bilateral symmetry of broiler chicken (mean ± SD) (mm)

Age (days)	Bilateral symmetry	Face length	Wing length	Leg length
28	Fluctuating asymmetry	0.12 ± 0.03^{b}	0.42 ± 0.05	0.09 ± 0.02
	Anti – Symmetry (FA)	0.12 ± 0.03^{b}	0.42 ± 0.05	0.09 ± 0.02
	Relative asymmetry	3.99 ± 0.86^{b}	2.47 ± 0.30^{b}	0.01 ± 0.01
	Directional asymmetry	3.16 ± 0.02^{b}	16.84 ± 0.07^{b}	275.56 ± 2.98^{b}
35	Fluctuating asymmetry	0.12 ± 0.01^{b}	0.42 ± 0.06	0.09 ± 0.03
	Anti – Symmetry (FA)	0.12 ± 0.01^{b}	0.42 ± 0.06	0.09 ± 0.03
	Relative asymmetry	4.07 ± 0.38^{ab}	2.83 ± 0.33^{b}	0.01 ± 0.01
	Directional asymmetry	3.45 ± 0.02^{b}	18.09 ± 0.07^{ab}	276.21 ± 2.67^{b}
42	Fluctuating asymmetry	0.14 ± 0.01^{a}	0.42 ± 0.05	0.11 ± 0.06
	Anti – Symmetry (FA)	0.14 ± 0.01^{a}	0.42 ± 0.05	0.11 ± 0.06
	Relative asymmetry	4.16 ± 0.25^{a}	3.17 ± 0.24^{a}	0.02 ± 0.02
	Directional asymmetry	3.59 ± 0.01^{b}	19.06 ± 0.05^{a}	278.69 ± 3.80^{a}
49	Fluctuating asymmetry	0.15 ± 0.01^{a}	0.45 ± 0.05	0.15 ± 0.01
	Anti – Symmetry (FA)	0.15 ± 0.01^{a}	0.45 ± 0.05	0.15 ± 0.01
	Relative asymmetry	4.47 ± 0.01^{a}	3.86 ± 0.30^{a}	0.03 ± 0.01
	Directional asymmetry	4.29 ± 0.02^{a}	19.51 ± 0.12^{a}	278.71 ± 3.80^{a}

[a, b] means of different superscripts along the same column are significantly different ($p < 0.05$); SD – Standard deviation

Table 4: Interaction effects of strain × stocking density on bilateral symmetry of broiler chickens

Variables	Arbor Acres			Marshal			Ross		
(mm)	10 birds.m^{-2}	12 birds.m^{-2}	14 birds.m^{-2}	10 birds.m^{-2}	12 birds.m^{-2}	14 birds.m^{-2}	10 birds.m^{-2}	12 birds.m^{-2}	14 birds.m^{-2}
FAFL	0.04 ± 0.03^{b}	0.04 ± 0.04^{b}	0.07 ± 0.04^{a}	0.03 ± 0.03^{b}	0.01 ± 0.02^{c}	0.05 ± 0.03^{b}	0.02 ± 0.02^{c}	0.02 ± 0.03^{c}	0.06 ± 0.02^{a}
ASFL	0.04 ± 0.03^{b}	0.04 ± 0.04^{b}	0.07 ± 0.04^{a}	0.03 ± 0.03^{b}	0.01 ± 0.02^{c}	0.05 ± 0.03^{b}	0.02 ± 0.02^{c}	0.02 ± 0.03^{c}	0.06 ± 0.02^{a}
RAFL	1.14 ± 0.81^{c}	4.47 ± 1.22^{b}	5.34 ± 1.23^{a}	0.86 ± 0.86^{d}	0.41 ± 0.74^{d}	0.09 ± 0.03^{e}	3.50 ± 0.61^{b}	6.19 ± 0.93^{a}	1.64 ± 0.53^{c}
DAL	3.40 ± 0.05	3.39 ± 0.05	3.42 ± 0.04	3.38 ± 0.05	3.37 ± 0.04	3.35 ± 0.05	3.39 ± 0.04	3.34 ± 0.03	3.34 ± 0.04
FAWL	0.55 ± 0.05^{a}	0.18 ± 0.08^{c}	0.38 ± 0.11^{b}	0.32 ± 0.09^{b}	0.18 ± 0.09^{c}	0.43 ± 0.08^{a}	0.56 ± 0.07^{a}	0.54 ± 0.07^{a}	0.33 ± 0.08^{b}
ASWL	0.55 ± 0.05^{a}	0.18 ± 0.08^{c}	0.38 ± 0.11^{b}	0.32 ± 0.09^{b}	0.18 ± 0.09^{c}	0.43 ± 0.08^{a}	0.56 ± 0.07^{a}	0.54 ± 0.07^{a}	0.33 ± 0.08^{b}
RAWL	3.06 ± 0.29^{a}	1.09 ± 0.46^{c}	2.15 ± 0.64^{b}	1.74 ± 0.53^{c}	0.34 ± 0.51^{d}	2.40 ± 0.46^{b}	3.08 ± 0.67^{a}	3.05 ± 0.39^{a}	2.00 ± 0.46^{b}
DAWL	17.95 ± 0.19	17.71 ± 0.15	17.54 ± 0.18	18.15 ± 0.15	18.13 ± 0.21	18.11 ± 0.17	18.14 ± 0.14	18.05 ± 0.18	17.36 ± 0.20
FALL	0.03 ± 0.08^{b}	0.05 ± 0.04^{b}	0.03 ± 0.01^{b}	0.09 ± 0.05^{a}	0.02 ± 0.03^{b}	0.08 ± 0.03^{a}	0.04 ± 0.08^{b}	0.04 ± 0.01^{b}	0.04 ± 0.00^{b}
ASLL	0.03 ± 0.08^{b}	0.05 ± 0.04^{b}	0.03 ± 0.01^{b}	0.09 ± 0.05^{a}	0.02 ± 0.03^{b}	0.08 ± 0.03^{a}	0.04 ± 0.08^{b}	0.04 ± 0.01^{b}	0.04 ± 0.00^{b}
RALL	0.02 ± 0.03	0.02 ± 0.02	0.01 ± 0.00	0.03 ± 0.02	0.01 ± 0.01	0.03 ± 0.01	0.01 ± 0.03	0.01 ± 0.00	0.02 ± 0.00
DALL	275 ± 5.65^{b}	271.75 ± 5.74^{b}	270.54 ± 6.07^{b}	263.62 ± 4.83^{c}	284.92 ± 2.57^{a}	281.15 ± 5.60^{a}	286.09 ± 1.62^{a}	286.25 ± 2.42^{a}	277.56 ± 5.16^{b}

^{a,b,c,d} means of different superscripts along the same row are significantly different ($p < 0.05$); Fluctuating Asymmetry of Face Length (FAFL), Relative Asymmetry of Face Length (RAFL), Fluctuating Asymmetry of Wing Length (FAWL), Relative Asymmetry of Wing Length (RAWL), Directional Asymmetry of Wing Length (DAWL), Fluctuating Asymmetry of Leg Length (FALL), Relative Asymmetry of Leg Length(RALL), Directional Asymmetry Leg Length (DALL) suggested measure or index of developmental instability, low FA is an indicator of small deviation from perfect symmetry (Moller and Manning, 2003). Highest RA was obtained in the Ross strain while highest DA was recorded in the Marshal strain. Also, there was significant effect of strains ($p < 0.05$) on DA of leg length of the chicken with Ross recording highest DA for leg length. However, there was no significant effect of a strain on FA, Anti-Fluctuating Asymmetry and RA of leg length of the chicken. Similar result was obtained by Moller *et al.* (1999), who reported that plumby genotype of broiler chicken may be responsible for the longevity in one part of the body than the other.

Table 2 shows the effect of stocking density on bilateral symmetry of broiler chicken. The results show that the effect of stocking density on bilateral symmetry of face length of the broiler chicken was significant ($p > 0.05$). The bilateral symmetry of wing length was significantly ($p < 0.05$) affected by the stocking density of chicken. Highest FA for wing length was obtained in birds raised on 10 birds.m^{-2}. This implies that highest deviation from perfect symmetry was obtained for birds raised on 10 birds.m^{-2}. Contrarily, Mirtagioglu *et al*. (2013) reported low deviation from perfect symmetry for chickens raised at stocking density of 11 birds.m^{-2}. Also highest DA for wing length was recorded in birds raised at stocking density of 10 birds.m^{-2}. However, there was significant effect ($p < 0.05$) of stocking density on DA of leg length in birds raised at stocking density of 12 birds.m^{-2} which recorded the highest DA for leg length. This is an indication of high importance of rearing factor, condition or environment in production cycle as reported by Skubic (2007).

There were significant effects ($p < 0.05$) of age on bilateral symmetry of face length of the chicken (Table 3). The highest value for bilateral symmetry of face length was obtained when the birds were 56 days old. Age also had significant effect on DA at 56 days old of the broiler chicken. Also the bilateral symmetry of wing length was significantly affected by age. The RA and DA of wing length were significantly affected by age with the highest values obtained when the birds were 56 days old. FA of the wing length was not affected by age, although the highest DA for wing length was obtained when the birds were 56 days old. DA for leg length of the broiler chicken was significantly affected by age with highest DA for leg length. However, the FA and RA were not significantly affected. This result showed that there was increment in the parameters measured as the broiler chicken aged. This was in agreement with the report of Palmer and Strobeck (1992).

Table 4 shows the interaction effects of strain and stocking density on bilateral symmetry of broiler chicken. There were significant ($p < 0.05$) interaction effects of strain and stocking density on bilateral symmetry of broiler chicken. Arbor Acres raised on 14 birds.m^{-2} had highest FA for face length. Ross raised on 12 birds.m^{-2} had the highest RA for face length. Highest FA for wing length was obtained in Ross chicken raised on 10 birds.m^{-2}. Highest FA for leg length was obtained in Arbor Acres raised on 10 birds.m^{-2}, while highest DA for leg length was also obtained in Ross chicken raised on 12 birds.m^{-2}. There was increase in the body parts with the decrease of stocking density in relation to the strain of chicken which confirmed significance on the investigated interaction effects in accordance with the results obtained by Skubic *et al*. (2007), which also indicate importance of this rearing factor in the production cycle. Moller and Manning (2003) have also indicated that animals kept under high stocking density had enhanced FA and lower growth rate.

CONCLUSION

Based on the results of the study it can be concluded that the bilateral symmetry of morphological traits, as estimated by DA, FA and RA, was affected by a strain and stocking density. Also, the bilateral symmetry increased with increase in the age of the birds. Marshall Broiler chicken performed best and they can be raised at 10, 12, and 14 birds.m^{-2}, whilst Arbor Acres and Ross chickens can be raised at 10 and 12 bird.m^{-2}. Strain and stocking density may be claimed as important factors affecting developmental stability of broiler chickens.

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