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Morphological Asymmetry and Broiler Welfare

ABSTRACT

Health status, feed conversion ratio, and mortality are long known broiler chicken production indicators. However, further parameters are required by today's demanding meat markets, as these indicators are not sufficiently accurate to determine flock overall welfare. Morphological asymmetry has been pointed as an alternative welfare indicator as it reflects the ability of the bird to cope with the challenges that rearing conditions may impose. This study aimed at evaluating the possibility of using morphological asymmetry as a welfare indicator. Broilers from 28 to 42 days of age were used in the trial. Birds were randomly selected in a commercial poultry farm and transported to the laboratory. They walked over the force measurement platform in order to determined their feet force as a percentage of body weight. The following body parts of the live birds were measured by two different operators using a digital caliper: tarsometatarsus length, outertoe length, midtoe length, and backtoe length. In the corresponding carcasses, the following traits were measured: wattle width, eye length, and first secondary feather length. Data were submitted to statistical analyses and no correlation was found between specific feet trait measurements and walking ability. Considering the time budget involved in measuring morphological asymmetry, this procedure did not appear to be a practically feasible welfare indicator.

INTRODUCTION

The latest focus of animal welfare research is to provide evidence on how certain genetic and rearing components may affect animals' expressive response and biological functioning (Dawkins et al., 2004; Broom, 2006). Productive response can be measured by feed conversion ratio and mortality as a result of several factors, such as flock or herd health status (Kestin et al., 2001). However, animal “affective” reaction cannot often be directly predicted, and indicators of animal “affective” status need to be carefully observed in order to allow more precise welfare estimation (Hall, 2001; Sanotra et al., 2002). The correct deduction of animal “affective” status based on such indicators may improve with the number of observed factors (behaviors, reactions, environment, etc.), and must involve multiple elements that should be combined in order to provide an accurate welfare prediction (Tuyttens, 2003). Morphological asymmetry (MA) has been pointed as a potential animal welfare indicator as it reflects the ability of an individual to cope with the challenges that may affect its growth during a certain period of life (Tuyttens, 2003; Broom, 2006; Knierim, 2007). Asymmetry is defined as random direct deviations from perfect growth symmetry that is generally expected in certain body parts when there was a successful control of the morphological development, and it is a result of both genetic factors and environmental conditions.
Leg deformities are an important problem in the poultry industry, and it is suggested that it is related to breeding (Kestin et al., 1992; Boekker & Koene, 2003), rearing conditions (Gonzales & Macari, 2000; Dawkins et al., 2004), and stocking density (Sorensen et al., 2000; Hall, 2001). In commercial production, it has been reported that 26 - 31% of the broilers suffer leg abnormalities which severity compromises their behavioral pattern and welfare (Kestin et al., 1992; Sorensen et al., 2000; Reiter & Kutriz, 2001; Bokkers & Koene, 2003; Weary et al., 2006). A large proportion of leg disorders result in reduced ability to walk, causing unnatural biomechanical forces and gait changes (Kestin et al., 1999; Hall, 2001). Reduced walking or standing ability often leads to breast blisters and hock burns as the bird has to spend a long time crouching on poor quality litter. In addition, lameness causing behavioral restriction and pain has become a major welfare concern (Reiter & Kutriz, 2001; Weary et al., 2006).

The objective of this study was to evaluate morphological asymmetry associated to locomotor characteristics of broilers after the fourth week of rearing as a predictor of welfare status.

**METHODOLOGY**

The experiment was conducted at the Center for Technology of the State University of Campinas, Brazil, on February 2 to 4, 2008, and approved by the Animal Experimentation Ethics Committee of the School of Veterinary Medicine and Animal Science, UNESP State University, Botucatu, Brazil, Protocol n. 182/2007.

**Bird management**

Nine Cobb® 500 male broilers of 28, 35, and 42 days of age (three of each) were randomly selected in a commercial poultry farm, where they were reared at an average stocking density of 13 birds per m². Birds were transported in boxes for 35km to the laboratory early in the morning to prevent heat stress and unnecessary discomfort before the trial. Immediately after arrival at the experimental facility, birds rested for 30 min and were offered water. Each bird was identified by a number, and had its head marked with a different color to allow individual recognition. The birds were weighed, and then placed in boxes according to age.

Gait assessment started with the youngest birds, as described below.

**Walking effort measurement**

In order to determine the force exerted by the bird’s feet while walking, a chamber with a walking runway was built. The chamber was 0.48m wide, 0.70m high and 1m long with transparent acrylic walls, a 0.20m inlet ramp, a horizontal plateau of 0.60m in the middle, and a 0.20m outlet ramp. Both inlet and outlet ramps had an angle of five degree from the floor, as shown in Figure 1a. A 0.01m step was carved in the horizontal plateau of the walking area and a thin mat (0.01m) of piezoelectric crystal sensing elements (Tekscan®) was placed inside it to measure broiler’s feet (right and left) walking force as the bird walked across the walkway (Figure 1b).

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**Figure 1** - View of the broiler feet force measurement system (a) and a broiler walking on the force platform system with the video cameras capturing the movement from the top and side angles.
The force-measurement platform system (FMPS) consisted of two parts: hardware (force mat including about two thousands sensels organized in columns and rows) that recorded the pressure data and transferred them to the software, which recorded feet force distribution, as well as processed and analyzed the recorded data. The output of each sensel was divided into 256 increments, and read by the software in values called raw sum, ranging from 0 to 255. The software was set up in a desktop computer, and data were saved for further analysis, as used in earlier studies (Carvalho et al., 2005; Oviedo-Rondón, 2007). The force mat was calibrated to the average weight of the birds in each box for each different age group.

Morphological measurements

All morphological measurements were carried out using a digital caliper (to the nearest 0.01mm), except for first secondary feather length, which was measured with a ruler (to the nearest 0.5mm). The left and right sides of the following four bilateral traits were measured twice in intact alive birds by two different persons (Van Nuffel et al., 2007; Van Poucke et al., 2007):

- **Tarsometatarsus length - TL** (distance between the joint of the tarsometatarsus with the tibiotarsus and the proximal skin fold on the midtoe, holding the tibiotarsus perpendicular to the tarsometatarsus and holding the midtoe in line with the latter);
- **Outertoe length - OL** (distance between the outer skin folds on the fourth phalanx when folding the outertoe);
- **Midtoe length - ML** (distance between the outer skin folds on the third phalanx when folding the midtoe), and
- **Backtoe length - BL** (distance between the tarsometatarsus and the nail, holding the backtoe perpendicular to the tarsometatarsus).

The following traits were measured in the corresponding carcasses:

- **Wattle width - WW** (distance between outer junctures);
- **Eye length - EL** (distance between eye corners);
- **First secondary feather length - FL** (total feather length after plucking).

Experimental procedure

The experiment consisted in recording information on bird walking ability on the FMPS. After stimulated to walking on the FMPS and arriving at the opposite side, broilers were gently picked up, and both left and right traits (TL, OL, ML and BL) were measured. Birds were then immediately slaughtered by cervical dislocation and WW, EL, and FL were measured, as suggested by Van Nuffel et al. (2008).

Statistical analysis

Logarithm scale was used in order to amplify the measured data. Recorded data were submitted to two-way ANOVA: the force applied as percentage of body weight (BW) was used to verify the variability between groups and within the group for each foot, and the measured morphological traits (left and right) were compared by Students paired t-test at a confidence interval of 95%. Data were analyzed using Minitab (2004).

RESULTS AND DISCUSSION

Table 1 shows the morphological traits measurements and the feet force as percentage of bird body weight. Average body weight was 1,391.67 ± 2.65g for 28-day-old broilers; 2,230.00± 5.05g for 32-day-old broilers, and 2,912.50± 6.37g for 42-day-old birds.

At 28 days of age there was no significant morphological differences between the left and right sides in five measured traits (WW, EL, FL, TL and ML). However, outertoe length (OL) and backtoe length (BL) values presented significant difference, as well as the force exerted on the FMPS by the left (7.31 %BW) or the right foot (6.73 %BW). This means that 28-day-old birds presented an uneven way of walking. No correlation was found between force and the measured traits.

The 35-day-old birds showed significantly different wattle width (WW) and the midtoe length (ML), and also presented different body balance while walking as proportion of body weight (left=4.02 %BW and right=3.42 %BW).

At 42 days of age there were morphological differences in wattle width (WW) and the midtoe length (ML), and also presented different body balance while walking as proportion of body weight (left=4.02 %BW and right=3.42 %BW).

At 42 days of age there were morphological differences in wattle width (WW), first secondary feather length (FL), midtoe length (ML), and backtoe length (BL); however, there was no difference in the force exerted on the FMPS between the left and the right feet. No correlation was found between gait response and traits measurements.

The findings of the present study do not indicate that morphological asymmetry in broiler feet structures may cause poor walking ability, as indicated by Moller & Manning (2003). Distinct results were also reported
by Resch-Magras et al. (1993), cited by Oviedo-Rondón (2007), who found that some specific leg conditions can create asymmetry in walking forces, which result in asymmetrical bone development of each leg leading to lameness in turkeys. According to Bizeray et al. (2000), asymmetrical bone development is naturally compensated by asymmetric gait, which may cause future lameness, and has negative impact on the welfare as it makes it difficult for the bird to reach feeders and drinkers, and ultimately causes pain (Weeks et al., 2000; Kestin et al., 2001, Manning et al., 2007).

Broiler plantar pressure is not evenly distributed across the plantar surface of each foot during walking, but it is concentrated in the areas of the digital pads. In general, the metatarsal pad is subject to lower pressures, with the highest pressures seen on the back and medial toe (Corr et al., 1998). Those authors reported that when the broiler is walking, the back toe is submitted to high pressure as the foot initially contacts the ground, and the pressure decreases as the footstep progresses. Low pressures are recorded throughout the metatarsal pad and part of the middle toe; while higher pressures are initially found on the proximal part of the lateral toe. Pressures decreases in the middle of the footstep as the pressure rises on the proximal part of the medial toe. Therefore, the traits that may be correlated to walking ability are toe lengths (OL, ML, and BL).

The results of the present experiment showed that 28-day-old male broilers presented higher OL and BL asymmetry, and that feet plantar force (%BW) were proportional to OL, whereas the asymmetry found in 35-day-old broilers was correlated to ML. In general, no specific pattern correlating asymmetry with the measured traits was found. These results are consistent with those of Van Poucke et al. (2007), who found that MA may not be a sensitive indicator of welfare in broiler chickens. It is also known that MA constitutes a small signal (often >1% of the trait size) and that its applicability depends both on measurement accuracy and statistical power. Knierim et al. (2007) observed that larger sample sizes and more repeated measurements may increase correlation in morphological asymmetry studies. However, higher repeatability or the increase in the number of measurements also would increase the time budget during the measuring task, compromising the feasibility of using morphological asymmetry as an efficient indicator of welfare.

CONCLUSIONS

According to the results of the present study, specific morphological asymmetry associated to the force the bird exerts while walking as percentage of its body weight alone is not be a suitable indicator of broiler welfare.

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