BROILERS' TOES ASYMMETRY AND WALKING ABILITY ASSESMENT

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ABSTRACT: Brazilian poultry production nowadays occupies important position in world's economy due to its technological advancement, which associated to the development of genetic strains of high growth may cause deviation in the growth rate and harm production. Morphological asymmetry has been pointed as an indicator of welfare, as maintained the pattern that leads to balance, the broiler chicken would have its normal locomotion characteristics, freely reaching water and feed. Thus, the objective of this research was to verify the possibility of using morphological asymmetry for evaluating walking ability of broiler chicken. The research was done in the Technology Center, at UNICAMP. The experiment was made using biomechanics analysis and following, the toes were measured. Results found did not show asymmetry useful for determining the locomotion ability of broiler chicken. New studies are recommended in order to search for other correlations that might help to estimate at field level, the locomotion difficulties of broiler chicken.

KEYWORDS: animal welfare, biomechanics, morphological asymmetry.

ASSIMETRIA DOS PÉS DE FRANGOS DE CORTE E MEDIDA DE HABILIDADE LOCOMOTORA

RESUMO: A avicultura brasileira ocupa hoje importante posto na economia mundial devido ao seu avanço tecnológico que, associado ao desenvolvimento de linhagens genéticas de alta conformidade, pode comprometer o bem-estar animal, causar desvios de crescimento e prejudicar a produção. A assimetria morfológica tem sido apontada como indicador de bem-estar em aves, uma vez que, mantido esse padrão que propicia equilíbrio, o frango teria suas características de locomoção de maneira normal, acessando livremente água e comida. O objetivo desta pesquisa foi verificar a possibilidade de utilizar assimetria morfológica para avaliar a habilidade locomotora de frangos de corte. O trabalho foi realizado no Centro de Tecnologia, UNICAMP. O experimento foi realizado utilizando análise biomecânica e, em seguida, os dedos dos pés foram medidos. Os resultados encontrados não apontaram que a assimetria pode ser utilizada para a determinação da capacidade locomotora de frangos de corte. Novos estudos são recomendados, a fim de procurar por outras correlações que possam ajudar a estimar, em campo, dificuldades de locomoção em frangos de corte.

PALAVRAS-CHAVE: bem-estar animal, biomecânica, assimetria morfológica.

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INTRODUCTION

The trends of animal welfare assessment research focus on providing evidence on how certain genetic and rearing components may affect the animals' growth and productive response and its biological functioning (DAWKINS et al., 2004; BROOM, 2006). However, the performance of food animals often cannot be estimated directly, and indicators of the animal status need to be observed in order to supply more precise welfare estimation (HALL, 2001; SANOTRA et al., 2002).

Asymmetry is a result of both genetic factors and environmental conditions, and it is defined as random direct deviations from perfect growth symmetry, which are generally expected in certain body parts when there is a successful control of the morphological development. Morphological asymmetry has been pointed as a potential 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 time (TUYTTENS, 2003; BROOM, 2006; KNIERIM, 2007).

Lack in walking ability has become a major problem in poultry industry worldwide, and it is proved to be highly correlated to breeding, rearing environmental conditions and stocking density (KESTIN et al., 1992; SORENSEN et al., 2000; HALL, 2001; BOEKKERS & KOENE, 2003; DAWKINS et al., 2004).

In commercial farms it has been found an average of 30% of severe broiler walking deficiency, a number high enough for compromising their behavioral pattern, production and well being (KESTIN et al., 1992; SORENSEN et al., 2000; REITER & KUTRIZ, 2001; BOKKERS & KOENE, 2003). A large proportion of these problems are due to leg disorders which result in gait alteration that often leads to breast blisters and hock burn (KESTIN et al., 1999; HALL, 2001).

The objective of this study was to evaluate the possibility of using the broiler toes' morphological asymmetry for predicting their walking ability, considering that the toes are the support of the gait dynamic.

MATERIAL AND METHODS

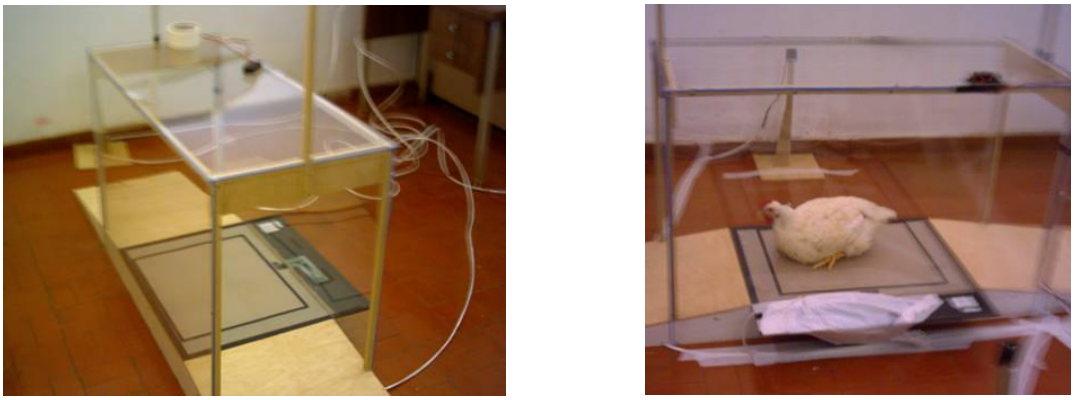
The research was done in the Technology Center, at UNICAMP using eleven broilers from the same commercial farm and genetic strain COBB® 500, and with ages of 49; 42; 35 and 28 days (two birds of 49 days old and three birds of the other ages). The experiment was approved by the ethical committee on animal experimentation of the School of Veterinary Medicine and Animal Science, State University UNESP, Botucatu, Brazil, Protocol n. 182/2007.

The experiment consisted of two parts. First the walking ability of broilers was measured using biomechanics analysis; then the toes were measured.

Experimental procedure

The birds were randomly chosen at a commercial poultry farm where they were reared at an average stocking density of 13 bird m^{-2}. Twelve broilers (three of each age) were selected in similar rearing conditions. They were transported in boxes throughout a distance of 35km to the laboratory to be used in the trial. Immediately after arrival at the experimental site the birds rested for 30 min and water was given *ad libitum* to them. A number was assigned to each bird, being written on its head with an animal mark coat for individual recognition. The birds were weighted and then separated in boxes by age. The experiment started with gait evaluation of the younger birds.

In order to assess the walking ability of broilers a chamber with transparent acrylic walls with the dimensions of 0.48 m wide, 0.70 m high and 1m long (with an inlet ramp of 0.20 m, a horizontal plateau of 0.60 m and an outlet ramp of 0.20 m) was built. Both inlet and outlet ramps had an angle of 5° from the floor (Figure 1a). In the horizontal plateau of the walking area a thin mat with piezoelectric crystal sensing elements - sensels (MatScan, Tekscan® Inc) was placed in order to measure the walking pressure of both broiler feet while it moved across the section (Figure 1b).



(a) (b)

FIGURE 1. View of the broiler feet pressure measurement system (a) and the broiler walking on the pressure system with a video camera capturing its movement from the side (b).

The pressure measurement consisted of two parts: the hardware (pressure mat) that recorded the pressure data and transferred them to the software, and the software that allowed the visualization of the pressure, process and analyze the data. The pressure mat hardware was formed by near two thousands sensels organized in columns and lines, approximately 1 sensor per cm^2. The calibration was done for each weight of the group of birds by selecting the average weight of the group. The output of each sensel was divided into 256 increments and read by the software in values called raw sun ranging from 0 to 255. The software installed in a desktop computer converted the captured values into a pressure map that could be seen in distinct colors in real time, and it was saved for further analysis. The experiment took place at the Technology Center, at the State University of Campinas, São Paulo Brazil.

Footage was taken from two digital video cameras (JVC GDR-120U - 30 Hz, 520 lines vertical resolution). The first camera was placed at a distance of approximately 1.0 m beside the plane of motion (wooden platform with the pressure system section used for plantar pressure data collection), as suggested by CARVALHO et al. (2005). The second camera was placed in the middle of the walking platform attached to a pole 1.3 m high. The cameras were aligned on its vertical and horizontal axis and at a 90° angle from the plane of motion.

The toes morphological measurements were taken with a digital caliper (to the nearest 0.01 mm). The left and right sides of the following four bilateral traits were measured twice on intact alive birds by two distinct persons (NUFFEL et al., 2007; POUCKE et al., 2007): Outer toe length - OL (distance between the outer skin folds on the fourth phalanx when folding the outer toe); Mid toe length - ML (distance between the outer skin folds on the third phalanx when folding the mid toe), and Back toe length - BL (distance between the tarsometatarsus and the nail, holding the back toe perpendicular to the tarsometatarsus).

Statistical analysis

Logarithm scale was used in order to amplify the measured data. The statistical analysis consisted in applying using two-way ANOVA on the registered data: the force applied as percentage of body weight (BW) for verifying the variability between groups and within the group for each foot; and the measured morphological traits (left and right) using Students paired *t*-test and confidence interval of 95%.

The Principal Component Analysis Technique was used to correlate or associate the variables by observing the vectors' (representing the variables present in the data base) magnitude and angle. Vectors with similar direction (next to 0° between them) are strongly positively correlated, and in opposite direction (next to 180° between them) indicate strong negative correlation. Vectors

showing an angle close to 90º are not correlated. The longer the vector the more the technique explains the correlation.

For the data statistical analysis the software Minitab®15 (MINITAB, 2006) and the multivariate analysis was applied in order to identify the existence of correlation or association between environment variables and production using the Principal Component Analysis Technique.

RESULTS AND DISCUSSION

The broiler 28 days old weighted 1,391.67 ± 2.65 g; the 35 days old had weight of 2,230.00± 5.05 g and the 42 days old presented an average weight of 2,912.50± 6.37 g. Results of the measurements of the toes' length and the force exerted in each toe are presented in Table 1.

No significant difference was seen in the left and right sides for 28 days old broilers in measured elements ML; however, the force exerted on the right mid toe was higher (48.70% BW) than the left one (21.60% BW). This indicates an uneven balance while walking leading to locomotion problems.

The recorded values of the outer toe length (OL) and the back toe length (BL) were different, and the force exerted in the right back toe was five times higher than the left one, indicating that the force while walking was higher in right side. These findings indicate that existing morphological asymmetry in 28 days old broilers may lead to poor walking ability, as indicated by MOLLER & MANNING (2003). Asymmetry in walking force as a consequence of asymmetrical bone development may lead to lameness, as found for turkeys by Resch-Magras et al. (1993) cited by OVIEDO-RONDÓN (2007).

The 35 days old birds showed significant difference in the measurements of the mid toe length (ML), and presented a difference in the body balance while walking, as proportion to the body weight (left=20.20% BW and right=12.90% BW). By 42 days of age the birds showed morphological differences in the measurements of the mid toe length (ML) and in the back toe length (BL), followed by significant difference in the force exerted in both right (4.10 %BW; 14.00% BW) and left side (17.40% BW; 32.20% BW) respectively. In general, during broiler locomotion the highest pressures are found on the back and medial toe (COOR et al., 1998). In this present experiment the force exerted were high but unevenly distributed in both right and left sides.

TABLE 1. Morphological toes' measurements and broiler force exerted on platform measurement system by both feet as percentage of body weight (% of BW) for birds from 28 to 42 days old.

Age (days)	28		35		42	
Morphological data (mm)	Left	Right	Left	Right	Left	Right
OL	17.67a	13.81c	15.35b	15.59b	15.47b	15.55b
Outer toe force (% BW)	7.30	7.20	13.60	1.90	20.70	15.10
ML	21.44d	21.53d	25.34a	24.36b	23.96c	25.78a
Mid toe force (% BW)	21.60	48.70	20.20	12.90	17.40	4.10
BL	17.91e	18.92d	20.07c	19.91c	24.13a	21.24b
Back toe force (% BW)	3.00	15.80	6.50	9.00	14.00	32.20

OL - Outer toe length; ML - Mid toe length; BL - Back toe length.
Same letter mean no significant difference in the confidence interval of P <0.05.

Asymmetrical bone development is naturally compensated by asymmetric gait which may cause future lameness, and results in negative impact on the broiler welfare, as the bird may present difficulties to reach feeder and drinker (BIZERAY et al., 2000; BIZERAY et al., 2004). The walking dynamic subjects the high pressures on the back toe as the foot initially contacts the ground, and then decreases as the footstep progresses. Low pressures were registered on part of the middle toe during walking path, while higher pressures were found initially on the proximal part of

the lateral toe, and later on forces decrease around midway through 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 the toes' length (OL, ML and BL).

When plotting the boxplot graph for all broiler measurements, it was found that the outer toe measurements increase the difference after the age of 42 days (Figure 2). Similar findings were obtained for the mid toe, and attention is called for the measurements value at 42 days (Figure 3), which show significant unbalance between sides. At 49 days old the asymmetry in both sides is visible high (Figure 4).

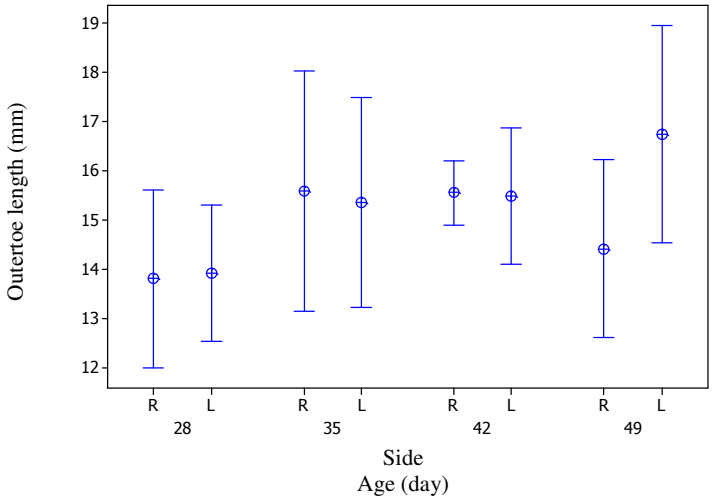


FIGURE 2. Outer toe length (mm) boxplot graph for both side right (R) and left (L) for broilers 28; 35; 42 and 49 days old.

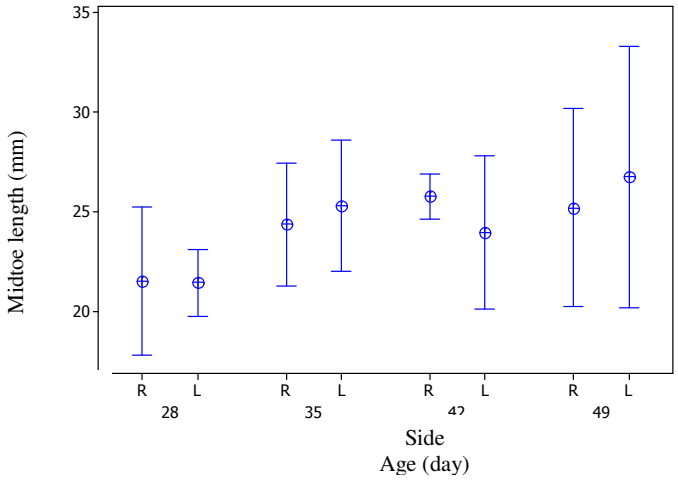


FIGURE 3. Midtoe length (mm) boxplot graph for both side right (R) and left (L) for broilers 28; 35; 42 and 49 days old.

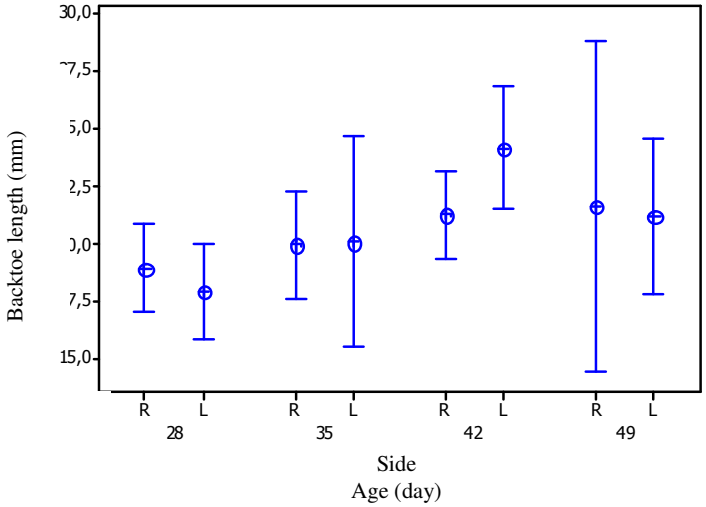


FIGURE 4. Backtoe length (mm) boxplot graph for both side right (R) and left (L) for broilers 28; 35; 42 and 49 days old.

POUCKE et al. (2007) state that fluctuating morphological asymmetry (FA) may not be a sensitive indicator of stress in broiler chickens unless a large number of measurements take place, which is not practical determination in the field. It is further known that FA constitutes a small signal (often >1% of the trait size) and that its applicability depends on both measurement accuracy and statistical power. KNIERIM et al. (2007) advocate the use of larger sample sizes and more repeated measurements for increasing 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.

Applying the Principal Components Technique (Figure 5 and 6) it is seen that there is a strong association between the measurements of mid toe and outer toe, as well as the back toe and age, and all variables are related (Figure 5). The length of all measurements was positively associated to the force exerted by the broiler while walking (as percentage of body weight), in the same way to age (Figure 6). WEEKS et al. (2000) found that lame birds change their behavior and generally have their welfare compromised. The findings in this experiment indicate that the older the bird the stronger the difference in the back toe, and less strong with the mid toe and the outer toe, indicating unbalance between sides as well (Table 1). There is then a potential for developing lameness, if not already lame birds were tested.

In general, a strong specific pattern for correlating toes morphological asymmetry in the measured traits was not found, and it does not justify special efforts in measuring those traits, even though DONGEN et al. (1999) has suggested a mixed regression model for estimating FA. The present results agree with POUCKE et al. (2007) who found that FA may not be a sensitive indicator of stress in broiler chickens.

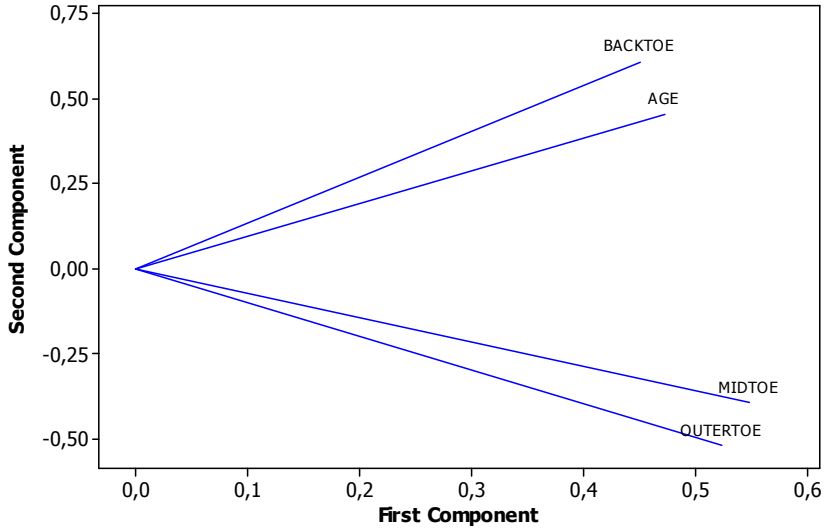


FIGURE 5. Associations between age of broilers and toe's length (OL, ML and BL).

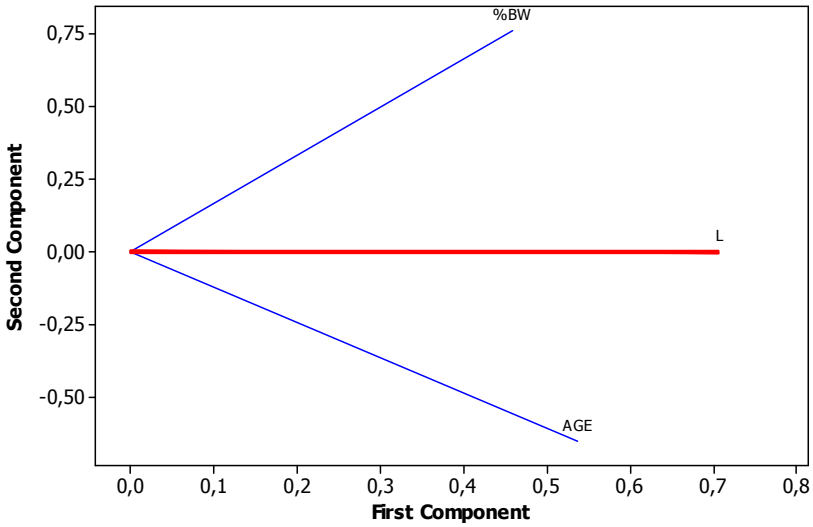


FIGURE 6. Associations between length of toes, age and force exerted as percentage of body weight.

CONCLUSION

Even though it was established correlation between the toes and gait analysis, measurements of broiler outer toe, mid toe, back toe morphological asymmetry was not clear in predicting walking ability for birds at 28; 35; 42 and 49 days old. Further studies are recommended in order to search for other correlations that may help estimate walking difficulties in broiler chickens.

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