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Multi-Criteria Analysis of the Influence of Rearing, Equipment, and Catching Management Practices on the Incidence of Back Scratches in Broilers

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ABSTRACT

Carcass quality is one of the main parameters to evaluate broiler welfare, and the presence of back scratches indicates that the birds were submitted to stress. The objective of this study was to identify the best management practices during rearing and catching, taking into consideration broiler genetic differences (genetic lines A and B) and sexes. The survey was carried out in 351 broiler houses belonging to an integrated company and located in the region of Dourados, MS, Brazil. Between January and October, 2010, 2% of broilers of all ages (one to 43 days old) in all flocks were sampled. The sampled flock was evaluated in 21 d intervals. Scratches were classified as present or absent. The results indicated that catching management has the strongest influence on back scratches (73%), followed by rearing management (17%) and equipment management (10%). In general, strain A females presented the lowest probability of presenting scratches after weighing, equipment management, and catching. It was concluded that, although rearing and equipment management practices affected the presence of scratches, catching caused the highest percentage of lesions in birds of both strains, and therefore, it is considered critical. Broilers from distinct that genetic strains reacted differently to management practices due to their temperament and growth rate. Therefore, broilers should be housed according to genetic strain due to their different temperaments.

INTRODUCTION

Broiler welfare and carcass quality are directly linked to scratches, which are caused by nails when birds crowd and are related to deficient feathering, litter problems, environmental factors, and stress (Allain *et al*., 2009). In addition, scratch lesions may be infected by microorganisms, impairing live performance (Macklin *et al*., 1999; Andrade, 2005). The incidence of scratches is influenced by management (Holroyd, 2000), rearing performance, type of equipment inside the broiler house, genetics (Garcia *et al*., 2002; Baracho *et al*., 2006; Allain *et al*., 2009), transport, and movement of people, vehicles, and animals (Hildebrand, 2005).

The increasing demand for poultry products and the need to reduce building costs required increasing productivity of poultry operations, with higher volume of meat produced per area. One practice adopted to achieve this higher productivity is to increase housing density in broiler houses (Luchesi, 1998; Moreira *et al*., 2001). However, overcrowding may impair broiler welfare, as shown by increased incidence of leg problems, carcass lesions, and mortality (Cobb-Vantress, 2009).

Some authors have reported that broiler strains derived from different genetic selection programs present different homeostasis

physiological response and different behavior, which affects their livability and performance as a function of the production environment (Cheng & Muir, 2005; Pereira *et al*., 2007). Modern broiler strains seem to react differently to environmental stresses, such as noise and feeder and drinker management. It was observed that one strain was more excitable than others, particularly during the first four weeks of life (Felix *et al*.,2011; Pilecco *et al*., 2011c).

There are different approaches to assess animal welfare: some emphasize physical attributes (growth and health), mental attributes (pleasure or suffering), and others assess the housing environment. In commercial poultry production, some indicators of welfare are used (Nääs *et al*., 2009), and carcass quality is one of the main parameters used to evaluate broiler welfare. The presence of back scratches indicates that birds were submitted to stressful situations or were reared at excessive housing density. Catching and loading at the end of the growout are crucial steps to obtain good chicken meat quality and carcass yield (Cobb-Vantress, 2009). However, not much attention is given to these final steps of broiler rearing, and processing losses may be significant. Catching method, transport time, lairage time, transport crate type, and rearing density were some of parameters that influence carcass lesions, as reported by Leandro *et al*. (2001).

High-performance broiler strains have high nutritional requirements and special management demands (Moreira *et al*., 2001). Carcass quality and live performance are influenced by the broilers' genetic potential, which also determines their temperament and particularly if they are calm or excitable (Holroyd, 2000; Andrade, 2005; Allain *et al*., 2009).

Broiler welfare and carcass quality are directly linked to lesions caused by scratches (Allain *et al*., 2009). When in fear, broilers usually tend to crowd in one end or wall of the poultry house, climbing on top of each other, scratching the other birds with their nails. The severity of scratches is related to deficient feathering, litter problems, environmental factors, and stress. The main situation that cause fear in broilers are the entrance of strangers in the poultry house and high and sudden noises, such as vehicle horns, when fans are turned on for the first time, feeder and drinker management practices, etc.

Because back scratches are caused by multiple factors, they can be assessed by multiple factors. Therefore, multi-criteria analysis methods can be used to evaluate back scratches. This study proposes the use of a multi-criteria analysis technique, called Analytic Hierarchy Process (AHP) for that purpose. This technique allows working with different groups of quantitative and qualitative factors to combine the results of different experiments, and has been used in many complex decision-making scenarios (Almeida Paz *et al*., 2010).

The objective of this study was to determine the best rearing and catching management practices for the reduction of back scratches in broilers of different genetic strains using the multi-criteria analysis process AHP.

MATERIALS AND METHODS

Location, birds, and management

The study was carried out in commercial broiler farms of an integrated company between January and October, 2010, located in the county of Dourados, Brazil, located between 22° 32' 10" S and 22° 16' 32" S latitude and between 55° 43' 32" W and 54° 09' 54" W longitude.

Broiler houses were 100 to 150 m long, 12 m wide, and 3.5 m high. Houses were equipped with automatic or manual feeders and drinkers and with ventilation systems (positive or negative pressure). All houses were made of bricks, had white-washed fiber-cement tiles, and were equipped with yellow polypropylene side-curtains, curtain protection, and dropped ceiling. Wood stoves were used during brooding. Minimum ventilation systems were used, as well as foggers. There were trees around the house for shade, and rice hulls were used as litter material.

Broilers from two genetic strains were evaluated. Strain A is characterized by early development, high feed intake, slow feathering, high nutritional requirements, high daily weight gain (average of 72.09 g $bird^{-1}$ day^{-1}), 1.68 average feed conversion ratio, and calm temperament. Strain B is characterized by compensatory gain during the last weeks of rearing, fast feathering, intermediate nutritional requirements, intermediate daily weight gain (average of 65.11 g $bird^{-1}$ day^{-1}), 1.75 average feed conversion ratio, excitable temperament, and resistant to diseases and heat. Broilers were housed per sex.

This meta-analysis included 894 samplings in 351 broiler houses in the micro-regions covered by the company. Broilers of all ages (1 to 43 days of age) were sampled, and 2% of the flock was collected per sampling. At the end of the experimental period,

275,000 broilers were evaluated, representing 5% of a total of 5,500,000 broilers housed, out of which 175,000 belonged to strain A and 100,000 to strain B and 136,000 were females and 139,000 were males.

Broilers were reared until 43 days of age at a density of 12.5 birds m^{-2}, and the lighting program adopted was that recommended by the manual of each genetic company.

Sampling

During the rearing period (one to 42 days), birds were sampled in six previously defined and opposite sites, longitudinally to the house. Back scratch lesions were classified as absent or present. At the end of the experimental period, 814 birds were sampled in 347 broiler houses. In three of these houses, back scratches were evaluated daily (from day 1 to 42), and in the other 344, lesions were assessed twice in 21-d intervals. The lesions found during these samplings were classified as rearing scratches.

When broilers were 43 days old, scratches were evaluated after catching, when birds were already inside the plastic crates, ready to be transported to the processing plant. Lesions were classified as rearing scratches, when there were signs of healing, or catching scratches, when there was recent bleeding. For this evaluation, 80 samplings were carried out in 80 different broiler houses. For analysis purposes, average catching time was classified as fast, when the flock was caught in less than 2.18h, or slow, when more than 2.18 was required.

In order to validate the data collected in the broiler houses, they were transformed in percentages and compared with the lesion rates observed at the processing plant after the sampled flocks were processed.

Data were submitted to analysis of variance and means were compared by the test of Scheffé at 5% significance level, with the aid of SOC statistical package (Software Científico: NTIA/EMBRAPA).

Analytic Hierarchy Process (AHP)

In order to determine the best management practices for both evaluated broiler strains, the obtained data were submitted to the analytical hierarchy process (AHP; Saaty, 1980). This process allows analyzing a multi-criteria problem to aid decision-making (Almeida Paz *et al*., 2010). Criteria hierarchy levels are based on qualitative and quantitative characteristics. Using consensus approaches, comparisons were made according to the mathematical model to build a matrix, where a_{ij} indicated the comparison of element i with element j in matrix A of paired comparison with n alternatives. The first approach requires the group of decision-makers to reach consensus on each aij entry in matrix A. The entry a_{ij} k indicates the comparison of the element i with element j for decision-maker k (k = 1,2 ,..., n) in the paired comparison of matrix A (Bolloju, 2001; Almeida Paz *et al*., 2010).

Criteria were paired-compared according to their possibilities of achieving the proposed objective (Saaty, 1980; Saaty, 1998).

Multi-criteria comparison was carried out to select broiler strain and sex that best adapted to the different rearing scenarios, according to the results obtained in the field. The criteria chosen for evaluation where those that were determinant in the statistical analysis in order to better contribute for the process (Figure 1).

The on-line software program AHPProject (2011) was used for the paired-comparison of criteria.

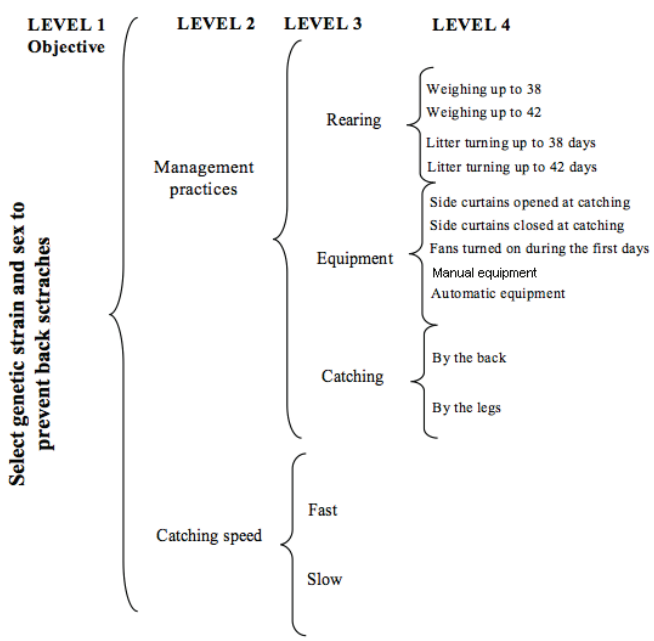

Figure 1 – Diagram of choice criteria for the objective of selecting genetic strain and sex to prevent back scratches.

RESULTS AND DISCUSSION

Multi-criteria analysis results indicated that catching management has the strongest influence on the incidence of back scratches in broilers (73%), followed by rearing management (17%) and equipment management (10%), as shown in Figure 2. This may be

explained by the fact that there are only four catching teams in the company, and each team handles a much higher number of birds compared with the farmers, that is, incorrect catching may affect 25% of the company's broilers, whereas incorrect rearing management may affect 10% of the birds, at the most. Scratches caused during rearing undergo healing, and depending on their severity and bird age, may not be apparent at the time of slaughter. On the other hand, scratches caused during catching are usually still bleeding when birds arrive at the processing plant and will result in carcass downgrading and trimming. According to Olivo (2006), back scratches are caused during rearing or at the time of catching mainly due to overcrowding. Losses due to bruises may be reduced by improving catching and transport management, as well as adapting slaughter equipment (Santana *et al*., 2008).

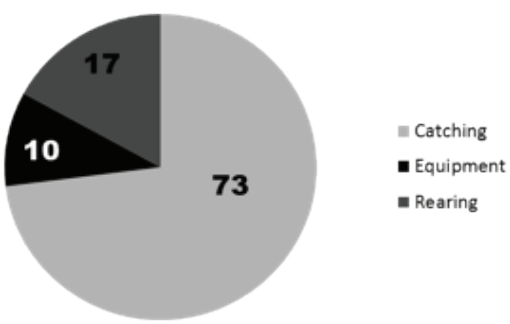

Figure 2 – Influence of management on the incidence of back scratches

Weighing birds weekly during the rearing period contributed to increase back scratch rates. The highest scratch rates were observed when birds were weighed up to 42 days of age and the lowest when birds were weighed up to 35 days of age (Pilecco *et al*., 2011a). Also, females presented lower scratch rates than males. Strain A females presented the best results in general, with 42.5% lower probability of presenting back scratches than all other broilers (Figure 3). When genetics was evaluated, strain A had lower back scratch rates than strain B. Females presented lower scratch rates because they were raised at lower densities (mass per area) than the males (strain A: females 32.3 kg m^{-2} and males 36.1 kg m^{-2}; strain B: females 33. kg m^{-2} and males 34.8 kg m^{-2}), and management practice that startle the birds increases scratch rates when broilers are housed at high densities (Pilecco *et al*., 2011 c). The lower rearing density also explains the better performance of strain A females. Garcia *et al*. (2002), studying the effect of rearing density on carcass lesions, also reported that high number of broilers per area, that is, increasing bird mass per area, resulted in worse carcass quality, mainly due to skin lesions. Broiler males are usually more excitable and gain more weight, and consequently present larger and deeper scratches than females, which in turn, present a higher number of skin lesions (Macklin *et al*., 1999; Garcia *et al*., 2002).

Strain A presented lower scratch rates than strain B probably because it has a calmer temperament. This is shown when scratch rates of males of both strains are compared. Although the rearing density of strain A males was higher, their probability of not presenting back scratches when weighed up to 42 days was lower (22.5% in strain A *versus* 12.5% in strain B). Also, there were no differences in scratch rates when strain A males were compared with strain B females (22.5% for both), due to the calmer temperament of strain A males, despite their higher rearing density. Strain A females presented the best general results because they were reared at the lowest density and present calm temperament. The effects of rearing density on carcass lesion density has been studied by other researchers, such as Baracho *et al*. (2006), who found that carcass condemnation rates increase in proportion with rearing density. Hildebrand (2005) reports that 10 to 30% of carcass downgrading in processing plants are related to scratch lesions.

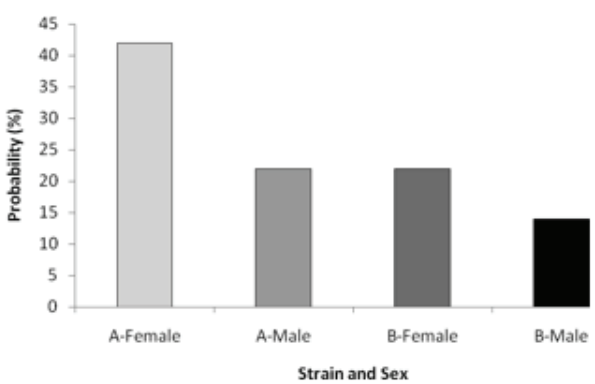

Figure 3 – Probability of broilers, according to genetic strain and sex, not being scratched after weekly weighing until 42 days of age.

In addition to weighing, the activity of turning the litter startles the birds, and therefore, must be properly performed. Broiler houses where litter was turned daily until market day (Figure 4) presented the same results as weighing for both strains and sexes. Studies have shown that reducing litter handling and weighing to up to 38 days of age reduced carcass lesions in the studied broiler genetic strains and for both sexes (Felix *et al*., 2011).

Figure 4 – Probability of broilers, according to genetic strain and sex, not being scratched after daily litter turning until 42 days of age.

Turning the fans on since the first days of housing habituates broilers to the equipment noise, and therefore does not startle them later in the rearing period, reducing the probability of scratches. This procedure was more effective in strain B broilers (Figure 5), which are naturally more excitable than strain A birds, reducing in 38% the probability of strain B broilers presenting back scratches independently of sex, in 12.5% in strain A males and in 8% in strain A females. Therefore, turning the fans on already in the first days of rearing allows reducing the losses caused by back scratches, particularly in more excitable strains that are more susceptible to crowding when startled.

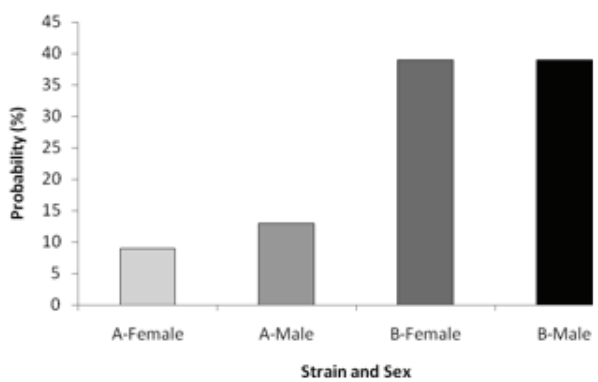

Figure 5 – Probability of broilers, according to genetic strain and sex, not being scratched when fans are turned on since the first days of age.

When considering equipment management, such as cleaning drinkers, filling feeders, turning fans on, and opening or closing the side curtains, strain A broilers presented lower scratch rates and females from both strains had lower probability of being scratched than males. Manual equipment caused more scratches than automatic equipment because filling and cleaning feeders and drinkers requires the frequent presence of people, which may startle the birds (Felix *et al*., 2011). Strain A seems to be more tolerant to changes in the rearing environment, as shown by the lower incidence of scratches after weighing and litter turning. In the analyzed broiler houses with manual equipment, strain A had less probability of presenting scratches than strain B, and strain A females had 48.1% probability of not having scratches (Figure 6). Again, this may be explained by the lower rearing density in female broiler houses. The influence of the space available to broilers during the rearing period on scratch rates was also reported by Allain *et al*. (2009). These authors evaluated the effect of age and body weight on the incidence of scratches in broilers and demonstrated that scratches increase as the space among birds decreases.

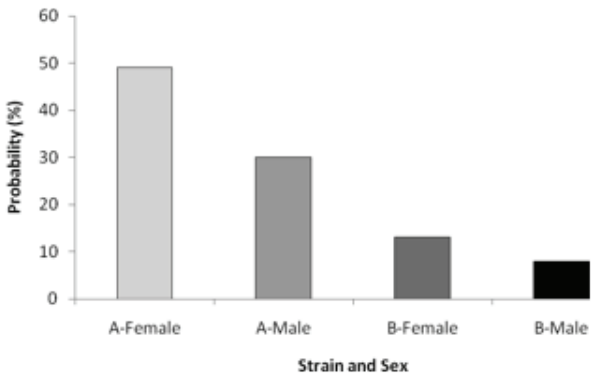

Figure 6 – Probability of broilers, according to genetic strain and sex, not being scratched in broiler houses with manual equipment.

In broiler houses with automatic equipment, strain B presented higher probability of not presenting scratches, and strain B females presented 45.4% probability of not being scratched (Figure 7). Strain B broilers were more excitable and crowded easier than strain A birds, which consequently resulted in a higher scratch percentage in B birds (Almeida Paz *et al*., 2011). Therefore, when houses are equipped with automatic feeders and drinkers, strain B broilers present a higher potential of not being scratched than strain A, as shown by the low scratch rates obtained in the results of the present study.

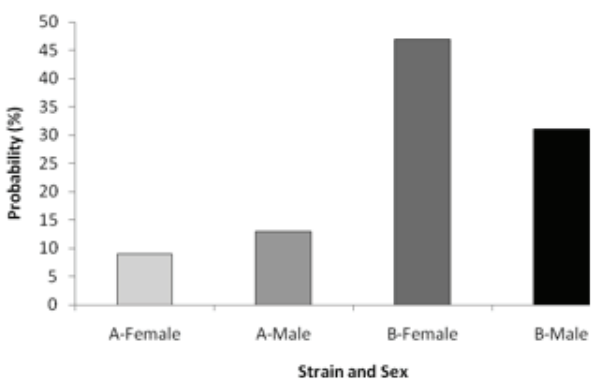

Figure 7 – Probability of broilers, according to genetic strain and sex, not being scratched in broiler houses with automatic equipment.

Curtain management during catching also influenced the incidence of back scratches. When the trucks used to transport broilers to the processing plant was moved when the side curtain was opened, birds were less startled than when the curtain was closed. It was strain B broilers were 14% more susceptible of being scratched than strain A birds (Figure 8) when the side curtain remained closed. Because they were calmer and heavier, strain A broilers moved slower and were not easily startled, presenting lower scratch rates at catching than strain B birds (Almeida Paz *et al*., 2011). Moreover, strain A females presented higher probability of not presenting back scratches (45%) even with the side curtain closed as the transporting truck approached than males of the same strain (27.5%). This is again explained the different housing density between sexes, which was 3.8 kg m^{-2} for strain A and merely 1.6 kg m^{-2} for strain B, not statistically significant (Almeida Paz *et al*., 2011). Therefore, stress caused by noise and transport truck movement showed higher influence than rearing density on scratch rates. Previous studies reported that male broilers presented higher scratch rates and deeper lesions, possibly because males are larger and heavier, reducing the space among birds and resulting in overcrowding (Garcia *et al*., 2002).

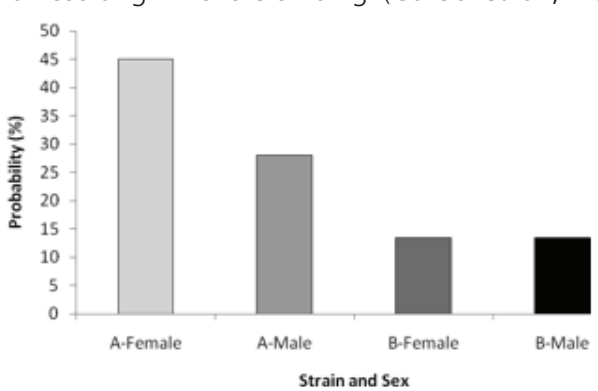

Figure 8 – Probability of broilers, according to genetic strain and sex, not being scratched when the side curtain is not opened when the transport truck approaches.

Broiler handling during catching was the factor with the most impact on scratch rates. Catching by the back, making no sudden movements and as quietly as possible, caused lower scratch rates in broilers (Cony, 2000). Proper handling during catching increases the probability of scratch reduction, particularly in strain A (Figure 9), which is less excitable. Strain A females presented better general results (42.5% lower possibility of being scratched), that is, they were the least affected by the evaluated factors, due to a combination of low rearing density and calm temperament. Strain A males and strain B females showed similar results (22.5% lower possibility of being scratched). This may be explained by the fact that, while strain A males are calmer and presented higher weight per area, strain B females are more excitable, but were reared at a lower density. Due to their fast growth rate, and consequent higher rearing density, together with their excitability, strain B males presented the least probability (12.5%) of presenting fewer scratches when caught by the back. Broilers naturally present deficient walking ability (Bokker & Koene, 2003), and when this is associated with high rearing density, carcass quality is impaired (Moreira *et al*., 2001; Cobb-Vantress, 2009).

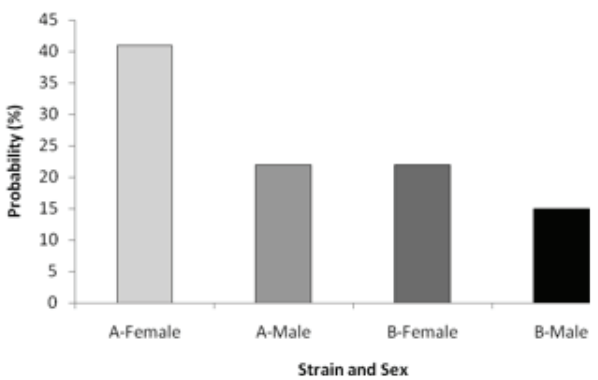

Figure 9 – Probability of broilers, according to genetic strain and sex, not being scratched when catching is carried out as described by Cony (2000).

Catching speed may also influence back scratch rates. When catching is fast, scratch rates increase. It was shown that slow catching, that is, longer than 2.18 hours for every 20,000 broilers, has a positive influence on scratch rates of male and female broilers of the same strains studied here (Pilecco *et al*., 2011b), reducing in 83.99% the incidence of scratches (Pilecco *et al*., 2011c).

In general, strain B broilers were more susceptible to back scratches when submitted to conventional management practices, such as cleaning and filling feeders and drinkers, and litter turning, until the end of the rearing period, and when the fans were turned on only when house temperature was high. Therefore, strain B broilers should be reared in houses with equipment that produce less noise and do not require the frequent presence of farmers, minimizing the incidence of back scratches. Strain A, despite also presenting better results when submitted to those practices, is more tolerant to manual management practices. The same differences were observed during catching, when strain B broilers presented higher incidence of back scratches when catching was fast (Figure 10).

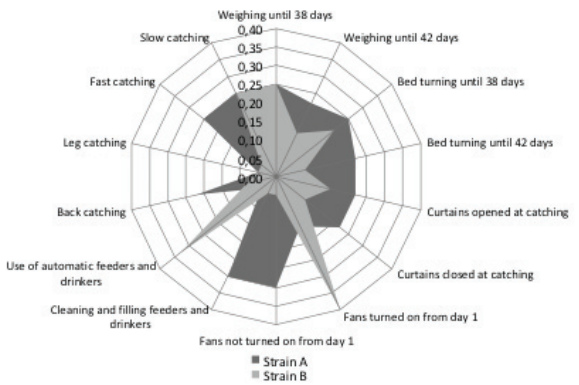

Figure 10 – Degree of importance of the different management practice on the absence of back scratches in two different broiler strains.

CONCLUSIONS

The use of multi-criteria analysis allowed showing the relationship among the different factors that cause back scratches in broilers. Although rearing and equipment management practices affected the presence of scratches, catching caused the highest percentage of lesions due to back scratches in birds of both strains, and therefore, it is considered critical. It was also found that genetic strains reacted differently to management practices due to their temperament and growth rate. Therefore, broilers should be housed and managed according to genetic strain as a function of their different reaction during rearing.

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