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Detection of flock movement and behaviour of broiler chickens at different feeders using image analysis

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A B S T R A C T

The behaviour of broiler chickens has been extensively studied as a function of stocking density and environmental conditions, but limited information was reported in the scientific literature about the effect of feeder type on birds' feeding process. The main objective of this study was to assess the effects of three different feeder types in relation to the birds' behaviour in its surroundings. The analysed feeders were: tube-type with partition grid (F1); tube-type without partition grid (F2); and automatic type with partition grid (F3). The considered variables were: occupied area (OA); activity index (AI) (flock movement); total birds presented in the area (TB); and birds effectively eating (EE). OA and AI were calculated by computational image analysis while TB and EE were manually measured. The results indicated that the feeder type could have influenced the birds' behaviour regarding to OA ($R^2 = 0.56$), TB ($R^2 = 0.48$), and EE ($R^2 = 0.40$), but AI ($R^2 = 0.01$) was not found to be directly influenced by the feeder type. A higher percentage of birds effectively eating were found in F2 (86.4%), which was the one with the largest free area to access the feed. Similar average number of total birds was found in F1, but with a lower percentage of individuals effectively eating (63.3%), which means that birds were nearby this feeder performing other behaviours. Since the assessed feeders were in the same house under the same conditions, it can be suggested that not only the free area to access the feed but potentially the design of feeders could have influenced the birds' feeding preference. The real beneficial effect of the adoption of partition grid on feed trays is still uncertain, and it is also unclear whether the financial value of reduced wastage would compensate the possible reduction in feed intake.

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1. Introduction

The feed is the most significant input in poultry production and has an over-riding effect on the financial viability on the production cycle [1,2]. Past and recent studies have been carried out in order to improve the feeding efficiency of broiler chickens in areas like ingredients' selection and feed processing methods [3,4], and the effect of feed particle size on flock performance [5–8] and gut development [9–11], but little is reported on literature about the impact and efficiency of different feeders on birds' feeding behaviour.

At the rearing environment, it is essential that feeders and drinkers be properly arranged and well managed. It has been suggested that the food sources distribution influence broiler chickens space use patterns. Besides, these patterns are not fixed but they can rather be adapted according to the dominant environmental conditions [12]. Moreover, the enclosure size has more influence on birds' movement and space use patterns than only stocking density itself [13]. It has been also suggested that design features like size, location, geometry, spacing and angle of feeders can affect the behaviour of animals [14,15]. Partition grids over feed trays are extensively used in the poultry industry as it is believed to promote a better distribution of the birds around the feeders and reduce feed competition and wastage [16].

Computational image analysis methods have been used to monitoring flock motion patterns of broiler chickens in different situations. It can be an efficient method to estimate the level of animals' welfare to improve flock management by aiding predictions for further decision making [17–23]. This study aimed to use computational image analysis techniques in order to access the behaviour of broiler chickens in a commercial house, when interacting with three different types of feeder, considering the flock motion, floor occupied area by the birds' body and eating behaviour.

2. Material and methods

2.1. Birds and facilities

The study was carried out in a conventional Brazilian commercial broiler building (100 m × 8.5 m), housing 14,000 broilers (Ross® genetic strain) with a stocking density of 16 birds/m^2 from 17 to 24 days of old, which is considered the steepest growth phase period for broilers [24]. Manual feeders were used during the first week, but after the second and third week both tube and automatic feeders were simultaneously used with bell-type drinkers. Axial fans (with built-in foggers) and side curtains were used for ventilation control. The concrete floor was covered with fresh pine shavings as bedding substrate.

2.2. Accessed feeders

The evaluated feeders were the (1). Fênix feeder (F1), which is a prototype not available commercially [25]; (2). manual tube-type feeder (F2) and; (3). automatic-type feeder (F3). Both F2 and F3 are available commercially. Both F1 and F3 had a partitioning grid attached to the feed trough, controlling the access of the birds to the feed. Birds fed on F2 feeders had full access to the feed. Therefore, each equipment presented distinct configuration in regards to access to feed (Table 1). The potential effect of the height of the feed trough edge on feeding patterns was not considered in this study.

2.3. Experimental procedure

Direct video footage was recorded in pairs (F1 versus F2; F1 versus F3) using a tripod with two video cameras attached from above (Sony DCR-TRV330®, Sony Electronics Inc., Park Ridge, NJ, USA; and JVC GR-D90UB®, Victor Company of Japan, LTD, Yokohama, Japan; Fig. 1). Analyses were carried out with the same amount of sampling for all feeders. The total floor area covered by the image was approximately 1.0 m × 1.5 m, with the feeder located at the centre. Each sample consisted of a 55 min of video footage twice a day, between 8:30 h and 10:30 h and 14:00 h to 16:00 h. Data were digitalized for further computational image analysis. Ambient variables were recorded at the centre of the pair of feeders at 30 cm above the floor using a HOBO® H8 data logger (Onset Computer Corporation, Inc., Bourne, MA, USA) at the sampling rate of 30 s. The variables monitored were dry bulb temperature (°C), relative humidity (%), and light intensity (l×).

2.4. Image analysis

The 55-min video sample was truncated to 25-min sample that was analysed at a one-minute interval. The first 10 min of the video footage was deleted to avoid the inclusion of the 'non-typical' behaviour of the birds in the analysis caused by the human presence while setting up the cameras. It was established a rectangular region (180 × 170 pixels; approximately 0.5 m^2) in the area of the feeders to carry out the analysis. The following variables were considered (Table 2): occupied zone (OA), activity index (AI), total birds presented in the area (TB), and total birds effectively eating (EE). OA and AI were automatically calculated using Matlab® software (MathWorks, Inc., Natick, Massachusetts, USA) while TB and EE were manually calculated by counting the individuals on the monitor.

To determine the OA each frame was binarised (Fig. 2b) based on a threshold level found using Otsu's method [26]. This image then was subjected to a morphological erode operation to minimize background noise (Fig. 2c). This process determined the area the birds occupied (white pixels) in relation to the background (black pixels), i.e. the ratio between the total area and the number of white pixels (corresponding to the birds). Thus, the actual approximate area occupied by birds could be found multiplying the ratio by 0.5 m^2. The AI was calculated based on the technique reported by [27], in which an algorithm analyse images to calculate activity, occupied zone and boundary of the animals according to the behavioural response to the referent micro-environment.

2.5. Statistical analysis

General Linear Model (GLM) procedure was adopted to assess the relationship between the variables (OA, AI, TB and EE) and