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Lighting in the Shackling Area: conciliating Broiler Welfare with Labor Comfort

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ABSTRACT

The objective of this study was to investigate if blue lighting could reduce broiler stress and comply with legal labor comfort requirements in a new shackling area of a middle-size processing plant. In this study, the old shackling area was compared with the new area, where a blue lighting system was designed and implemented according to the regulations. The old and new areas were video- and audio-recorded during the shackling of 33,850 broilers in each area. Data were statistically analyzed using the non-parametric test of Wilcoxon-Mann-Whitney (w test).The results indicated 56% reduction in wing-flapping and 3.2% noise reduction in the new area. These results were obtained by increasing 119% lighting at the work stations in the shackling area, allowing workers to handle the birds more carefully, which may improve processing plant productivity. The study demonstrated that it is possible to conciliate better animal welfare with visual comfort for workers in the shackling area.

INTRODUCTION

Quality attributes of animal products include good production practices and their association with animal welfare and workers' wellbeing, as well as food safety and environmental aspects, which determine the ethics of animal production (UBA, 2008).The legislation on animal welfare has greatly developed during the last few years. In the United Kingdom, for instance, each processing plant must have a worker trained on bird welfare to oversee unloading, lair age, and slaughter (ACP, 2007).

Animal rearing and rearing technologies are dynamic fields that can have positive or negative influences on animal welfare. A pro-active approach, aiming at ensuring that neither technological development nor animal welfare are compromised, is recommended (Clark *et al.*, 2006; Koknaroglu & Akunal, 2013).

Pre-slaughter aversive conditions and consequent physical and mental stressors affect both animal production (meat yield and quality) and welfare. These issues are related, as discussed by Gregory (1996) in an article on animal welfare and carcass hygiene.

Deep *et al.* (2012) studied the effect of light intensity on broiler welfare in the processing plant. Lighting can have a positive or negative influence on broiler welfare because it affects their behavior. Lighting is widely used for the manipulation of the behavior of meat-type poultry (Nixey, 1994; Lewis *et al.*, 2004; Kristensen *et al.*, 2007). Light distribution, duration, and intensity have a direct effect on flock performance and welfare. Adequate positioning and distribution of light sources stimulate birds to seek feed, water, and heat during the starter phase. During the grower phase, lighting can be used to moderate weight gain and to improve production efficiency and health of a flock (Mendes *et al.*, 2010).

Color perception of poultry is similar to that of humans, except for short-wave light. This has been used to improve the handling of broilers during catching. Because wavelength perception is different between broilers and humans, lighting sources are perceived as having different colors (Lewis & Morris, 2006).

The peaks of sensitivity of three types of cones in the human eye allow the perception of primary colors: violet/blue (450 nm), green (550 nm), and red (700 nm).When all cones are simultaneously stimulated, the brain preceives the light as white. Birds present an additional cone in the retina, which sensitivity peaks close to 415nm (Govardovskii & Zueva, 1977; HART *et al.*, 1999), allowing for the perception of radiation below 400nm (Prescott & Wathes, 1999).

Bird activity is reduced as light intensity diminishes. Using controlled and reduced lighting during catching minimizes possible physical and (or) emotional damages during this operation (Kristensen *et al.*, 2006). Blue light is recommended during catching, as the visual perception of broilers is greatly impaired, and therefore, they are not distressed. This could be extrapolated to the shackling sector of broiler processing plants, where reduced lighting with blue light is also recommended.

Due to environmental changes and handling to which broilers are submitted during shackling, stress is more intense and it is expressed as struggling, which may lead to processing losses, including broken bones, bruises, and meat quality defects like pale, soft, and exudative meat (PSE) or dry, firm and dark meat (DFD).

Workers must be properly trained, because skillful and fast shackling minimizes broiler stress. In addition, the environment must have good ventilation, low noise, and adequate lighting. The use of reduced light intensity and blue work clothes are recommended in order not to startle the birds and to transmit calmness (Komiyama, Ludtke, and Silveira, 2006).

The objective of the present study was the effect of environmental lighting on broiler stress by behavioral observations and by quantifying their struggle in the shackling sector of a processing plant. In this study, a conventional lighting system was compared with brighter lighting system designed to provide better visual comfort to workers in compliance with the Brazilian regulations (ABNT).

MATERIALS AND METHODS

The processing plant where the observations were made is located in the southwest of the state of Paraná, Brazil. The company slaughters and processes 60,000 broilers/day. The company has a feed mill, a hatchery, breeder farms, and 160 contracted farmers, and sells chicken products to the south, southeast, north, and northeast regions Brazil, as well as exports them to Asian countries. The company is expanding and remodeling its slaughter, processing, and further-processing lines, using cutting-edge machinery and automated equipment. The goal of the company is to process 170,000 broilers/day, or 10,000 birds/hour in two shifts. This expansion will be gradual, as it involves the other structures (breeder farms, hatchery, and broiler farms).

The study was carried out between 05/2011 and 08/2011 in two steps. In the first step, an existing shackling sector was evaluated. Blue lighting (blue fluorescent lamps) and natural light, which came from openings to the external area) were used. This step was called "old shackling area". The second step included the design and installation of fluorescent blue lamps with higher lighting intensity to promote better visual comfort to the workers. It was called "new shackling area". The old and new sectors have similar dimensions, as well as similar equipment and processing speed (~3,125 birds/h).

The number of times broilers flapped their wings in shackling line sector (*A*) was counted. Sector *A* included the distance between the last shackling station and the entrance to the stunner. Pereira *et al.*(2013) used a video camera during the experiment to monitor broiler behavior. Video recordings were made along the mentioned shackling line using a Canon Power Shot S 215 camera always from a fixed position. During five consecutive days of the same week, 65 10-min recordings (13/d) were carried out during processing times (06h00min to 23h10min), totaling 650 minutes of recordings at the end of the 5th day.

Recording were made to include all possible variables: days of the week, shift, and times, as well as flocks from different farms and sexes, and that had travelled different distances. Recordings were made in the new and the old shackling areas. The company works with a single broiler genetic strain (Cobb 500).

Data collection between the old and the new area was carried out as close as possible, but It was not possible to be simultaneous because of the works in the plant at the time of first collection. Therefore, the interval between data collections was three months.

In addition of the recordings, the following data were measured: air relative humidity, temperature, environmental noise (*R*) and luminosity. Temperature was measured using a thermometer (Instrutherm, model TGD 300) with a data logger, and a hygrometer. Noise was measured using a digital decibelimeter (Minipa) with data logger (MSL 1352C). Luminosity was measured using a digital luximeter (Instrutherm, model THDL-400).

Temperature, relative humidity, and luminosity were collected at the beginning of each video-recording, 13 times daily, for five days. Because it is a closed environment, temperature and relative humidity were measured in a single spot, near the shackling line. Luminosity was measured at three fixed spots of the shackling line (beginning, middle, and end of the video-recorded line stretch) at the birds' head height.

Environmental noise was measured using a decibel meter every second, simultaneously to 13 daily video-recordings.

After data in the old area was collected, the new lighting of the new shackling area was designed, and measurements were made. Lighting design of the new area try to conciliate the reduction of broiler stress (as measured by agitation) with better working conditions and better lighting comfort for the workers, according to regulation NBR 5413 (1992) of ABNT. An intermediate lighting intensity at the work stations was applied. This is called the method of average lumen lighting and it is the most adequate for routine work in a fixed working station.

Light intensity was determined considering the classification of the work in the shackling area as "tasks with limited visual requirement, gross machinery work, and auditoriums" of that regulation. In order to determine light intensity using the tables provided by the regulation, average worker age (younger than 40), the importance of task velocity and precision (shackling broilers), and background reflectance higher than 70% were considered. Therefore, a required average light intensity of 200 lux was determined (NBR 5413, 1992).

The size of the lighting system also considered shackling area dimensions (width, length, height), estimated reflections of the roof, walls, and floor, and light flow of the blue fluorescent lamps. Based on this data, the utilization factor was determined as 0.58. Considering that the area is a source of dirt emissions and that lamp maintenance and cleaning are made every 7,500 h, a depreciation factor of 0.80 was determined (Creder, 2007). Using the information on the environment and utilization and depreciation factor, the number of lamps required to obtain the desired light intensity of 200 lux in the new shackling area was calculated as 26.

This number is relatively high when compared with the number of conventional lamps that would be required because the light flow of the blue lamps available in the market is only 700 lumen, and because the area is relatively high (5.2 m). An alternative for reducing the number of lamps would be to reduce the height where they would be installed, using hanging lamps. However, this option was rejected by the company, which standard is to install the lamps on the ceiling in order to prevent dirt accumulation and cleaning problems. Lighting was measured in three different points of the video-recorded shackling line (beginning, middle, end), at birds' head height. As previously mentioned, light intensity was measured at three points (1, 2 and 3), according to shackling flow. Point 1 corresponded to the station of the last shackling worker, point 2 along the shackling line, and point 3 to the entrance to the stunner.

The method of evaluation applied to the new shackling area, after the blue lighting system was installed, was identical as that applied in the old shackling area, using the same video-recordings intervals, and humidity, temperature, noise, and luminosity data were recorded using the equipment described above.

Considering processing line speed and observation intervals, approximately 67,000 broilers were observed or 33,850 in the old shackling area and 33,850 in the new shackling area. The wing-flapping values obtained in broilers shackled in the old and the new areas are shown in Tables 1 and 2, respectively. As there were two groups, the medians of wing flapping in the old (A_{pa}) and new (A_{pn}) shackling areas were compared. The unilateral W (Wilcoxon-Mann-Whitney) test was applied at 5% significance level. The null hypothesis was that wing-flapping values were not different between the new and the old areas ($H_0 : A_{pa} = A_{pn}$). The alternative hypothesis was that there was more wing-flapping in the old area compared with the new area ($H_1 : A_{pa} > A_{pn}$).

RESULTS AND DISCUSSION

The values of wing-flapping are shown in Tables 1 and 2, respectively.

Table 1 – Number of wing-flapping in the old shackling area (A_{pa}) between 03/05/11 (day 1) and 06/05/11 (day 5).

Sample	Time	Day 1	Day 2	Day 3	Day 4	Day 5
1	6:00 - 6:10	56	40	46	33	37
2	7:00 - 7:10	101	30	39	43	64
3	8:00 - 8:10	56	36	32	32	41
4	9:00 - 9:10	46	37	34	38	42
5	12:00 - 12:10	57	69	41	48	63
6	13:00 - 13:10	65	44	39	36	74
7	14:00 - 14:10	55	56	40	95	37
8	15:00 - 15:10	30	33	58	80	38
9	16:00 - 16:10	36	35	37	58	23
10	17:00 - 17:10	63	62	35	64	31
11	18:00 - 18:10	37	41	37	60	64
12	21:50 - 22:00	35	32	64	41	46
13	23:00 - 23:10	41	38	72	48	52

Table 2 – Number of wing-flapping in the new shackling area (A_{pn}) between 08/08/11 (day 1) and 12/08/11 (day 5).

Sample	Time	Day 1	Day 2	Day 3	Day 4	Day 5
1	6:00 - 6:10	24	9	20	10	15
2	7:00 - 7:10	25	19	32	28	12
3	8:00 - 8:10	24	13	34	6	8
4	9:00 - 9:10	22	26	27	6	9
5	12:00 - 12:10	19	16	16	13	16
6	13:00 - 13:10	8	15	24	31	15
7	14:00 - 14:10	24	22	27	9	24
8	15:00 - 15:10	18	20	23	13	18
9	16:00 - 16:10	29	16	23	12	14
10	17:00 - 17:10	22	23	17	12	17
11	18:00 - 18:10	27	18	34	7	12
12	21:50 - 22:00	28	28	11	10	11
13	23:00 - 23:10	18	9	8	22	19

The results show that the null hypothesis ($H_0 : A_{pa} = A_{pn}$) was rejected (w = 43.5) at p< 0.01, indicating the wing-flapping values in the old area (A_{pa} = 41), as counted in 10-min intervals, is significantly higher than in thenew area (A_{pn} = 18), representing a reduction of 56% in wing-flapping.

The median (m) and standard-deviation values (s) of dry-bulb temperature (DBT), wet-bulb temperature (WBT), and relative humidity (RH) are presented in Table 3.There were some concerns with the 3-month interval between environmental data collection in the old and new areas.The new area presented less environmental variability, possibly because it presented better insulation from the external area compared with the old area.The conditions may be considered mild in both situations, complyingwith one of the assumptions of the study, which was not taking the influence of climate into consideration.

Table 3 – Climatic conditions during the evaluated periods.

Parameter	Old area (02 to 06/05/11)		New area (08 to 12/08/11)	
	m	s	m	s
DBT (°C)	16.54^{a}	3.6^{b}	19.6^{a}	1.8^{b}
WBT (°C)	15.5^{a}	2.7^{b}	18.3^{a}	1.2^{b}
RH (%)	89.7^{aa}	8.3^{b}	89.4^{aa}	5.6^{b}

[aa]Not significant and [a]significant, respectively, by the W test of medians (Wilcoxon-Mann-Whiney) at 5% probability level. [b]Significant by the F test at 5%probability level.

Noise results as measured in the old and new area are discussed below. The decibelimeter recorded instantaneous values every second. The expected value was 39,000 readings in 650 minutes (39,000 seconds). The obtained results were slightly different. In the old shackling area, noise was recorded for approximately 11h5min (39,902 readings) and for 10h38min (38,288 readings).

Noise median values were compared between the old (R_{pa}) and the new (R_{pn}) areas using the unilateral W (Wilcoxon-Mann-Whitney) test at 5% significance level. The null hypothesis was that noise was not different between the new and the old areas ($H_0 : R_{pa} = R_{pn}$). The alternative hypothesis was that noise was higher in the old area compared with the new area ($H_1 : R_{pa} > R_{pn}$).

The results show that the null hypothesis was rejected (w = -5.59x10^8) at p = 0.01, indicating that noise was significantly higher in the old shackling area. The level of noise in the old area was R_{pa} = 86,4 decibels, and R_{pn} ≤ 83,6 decibels in the new area.

The reduction of noise in the new area was 2.8 decibels, which is equivalent to 3.2%. Therefore, the new area presented more favorable conditions both for broilers and workers in terms of noise. Table 4 presents a summary of measurements, including the median (m), standard deviation (s) and the coefficient of variation of lighting (cv) at the evaluated spots.

According to the measurements, the new shackling area has better lighting; however, this not result in more bird activity (wing flapping) or more stress (Barbosa *et al.* 2013, Olanrewaju *et al.* 2011), as shown by wing-flapping observations and analysis (Tables 1 and 2). The higher variability of the old area is due to the influence of natural lighting.

Table 4 – Comparison of light intensity (lux) between the old and the new shackling areas.

Spot	Recommendations (lux) NBR 5413	Old area			New area		
		m	*s*	*cv*	*m*	*s*	*cv*
1	200	68.5[a]	10.8[b]	15.4%	150[a]	1.2[b]	0.8%
2	200	99.5[a]	157.8[b]	146.7%	185[a]	0.8[b]	0.4%
3	200	105.5[a]	39.4[b]	45.9%	170[a]	1.9[b]	1.1%

[a]Significant within the same column by the W (Wilcoxon-Mann-Whitney) test of medians at 5% probability level.

[b]Significant within the same column by F test at 5% probability level.

The lighting of the new area was close to the recommendations of NBR 5413 (1992) for work stations, of 200 lux. This was particularly the case of point 1, where average lighting level increased 81.5 lux or 119% relative to the old area. Out of the points evaluated, it is the one that best represents lighting where the workers shackle the birds.

It should be noted that better lighting allows better worker performance, as they will have less problems in shackling the broilers because they can see better what they are doing, which will also result in less broiler trauma and bruises.

CONCLUSIONS

Blue lighting in the shackling area of broiler processing plants contributes to reduce bird struggling. It is possible to conciliate reducing broiler struggling during shackling with light comfort of workers of the shackling area. Lighting comfort allows workers to handle birds more carefully, contributing to lower carcass losses.

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