Evaluation of the Effect of Vibration in Simulated Condition of Transport of Broiler Chickens

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Abstract. *Pre-slaughter vibration conditions of chicken transporting trucks were simulated in the laboratory, based upon data collected previously in the field. The objective was to assess the effect of vibration on the stress levels of chickens and obtain data for comparison with papers already done on the subject. Thirty chickens of approximately 7 weeks age were selected, then submitted to four hours of fasting, and allocated in transport cages (9 birds per cage). In order to simulate the transportation, the chickens were subjected to two different levels of vibration for four intervals of time (0, 30, 60 and 90 minutes). In each time interval, body weight and rectal temperature were measured in three birds, which were removed from the cage in the vibrating platform and replaced immediately, in order to avoid effects of training. It was aimed to use as an initial vibration a vector's sum level of approximately 2.8 m/s², which is the average of vibration found previously in the field. However, due to little control over the vibrating platform, the values exceeded up and were 8.7 m/s² and 22.25 m/s² on average, respectively, for the level 1 and 2 of vibration. Even with the vibration levels exceeding those found in the field, the vibration did not affect chicken rectal temperature for all treatments (different times and intensities) and no differences were found on weight loss for the chickens submitted to different levels of vibration.*

Keywords. *Broiler chicken, Vibration, Transportation, Pre-slaughter, Stress.*

Introduction

There are many factors that affect chicken welfare during pre-slaughter transportation. These combined factors affect the performance of the bird during the operation, but, if examined separately, it provides better understanding of whole process.

Vibration is any movement that a body or part of a body realizes around a fixed point. This movement can be regular, sine type or irregular, when it does not follow any particular pattern, as in a car trembling in a land road (Iida, 2005).

The vibration is defined in three variables. First, the frequency, measured in cycles per second or Hertz (Hz). Second, the intensity of displacement (in cm or mm) or maximum acceleration suffered in the body, measured in g (1 g = 9.81 m/s^2). The third variable is the direction of the movement, defined by three triorthogonal axis: *x* (from back to front), *y* (from right to left) and *z* (from bottom to top) (Iida, 2005).

It is known that the vibration varies with the suspension type, tires calibration, shock absorbers, applied speed (constant, speeding up or braking) and road quality, therefore, there are studies involving these variables and their relation with animals (Randall et al., 1993; Smith et al., 1996).

Human response to vibration has been studied in detail, as commented by Griffin (1972), cited by Randall (1993). The same author reported that the existing evidence of biological stress in animals during mechanical vibration suggests that significant physiological and psychological strain involved may lead to similar symptoms which occur in human beings when submitted to vibrations. Among these symptoms there are fear, nausea and muscular fatigue as a result of the complex distribution of oscillatory motions and forces within the body. In this work, the author measured the vibration in trucks with different types of shock absorbers normally used to carry chickens in the United Kingdom, finding values of acceleration (Sum of Vectors - RSS) of 0.84 to 2.58 m/s^2 and fundamental frequencies between 1 and 2 Hz with secondary peak at 10 Hz, in the vertical axis.

The mentioned effects that occur in human beings and other animals are also likely to occur in birds. Even with the dissimilarities of anatomy, physiology and innervations in different kinds of animals, the resonant frequency for a particular species indicates at which excitation frequencies body tissues are stressed and thus likely to cause discomfort (Randall, Cove and White, 1996).

The organism, as being a complex structure, with many bones, joints, muscles and organs, does not react uniformly to the effect of vibrations. Each part of the organism can either amplify or alleviate the vibrations. These amplifications occur when parts of the body start to vibrate in the same frequency and then we say that the body entered in resonance. The frequencies that cause this phenomenon are called resonance frequencies (Iida, 2005).

To quantify the aversion of the broilers to the vibration, Randall et al. (1997) related the human sensation with the reaction of the broilers to different frequencies and magnitudes of acceleration. For this, were used trained chickens and a passive-avoidance, operant-conditioning technique. Thus, measures of aversion based on choices were taken (the chicken were in conflict in their motivations to acquire their daily food ration and to avoid initiating the motion). The author concluded that broiler chickens find vertical motion to be more aversive than horizontal motion, particularly at frequencies above 1 Hz. Thus, at a fixed acceleration level, broiler chickens find high frequencies to be less aversive than lower ones.

Moreover, a scale of aversion to the vertical vibration for chickens was established based on similar scales existing for human, through measures of vertical acceleration (module acceleration - RMS): "not aversive" 0.16 – 0.315 m/s^2; "a little aversive" 0.315 – 0.63 m/s^2; "fairly aversive" 0.5 – 1.0 m/s^2; "aversive" 0.8 – 1.6 m/s^2; "very aversive" 1.25 – 2.5 m/s^2 and "extremely aversive" 2.0 – 4.0 m/s^2.

However, the chickens of this study were submitted only to short periods of vibration of 30 seconds, different of what occurs in the reality, with transports during until two hours. Thus, the chickens might have found that certain conditions become increasingly aversive, whilst others, initially aversive, became less as they habituated. Moreover, the chickens were evaluated individually and standing, differently of what occur in a real transport, where the chickens are in groups of 7 to 10 per cage and spent mostly of the journey lying. The act of lying down might be initiated because the resonant frequency of the vehicle of 1 – 5 Hz, which correspond to the resonant frequency to the standing bird of 3 – 4 Hz, causing muscular fatigue as they attempt to maintain postural stability. Once lying down, the vibration enters the body through the breast and the leg muscles rather than the feet and the birds are likely to perceive the motion in a different way to when they are standing (Randall, 1997). We may consider, also, the effects of acceleration and braking of the transportation vehicle. The resultant inertia acts in the chickens changing their position, when the acceleration is not so strong, but it can cause damages to the carcass, when the acceleration is brusque (shock). On the bed of the truck, fore-aft motion due to rapid braking or acceleration severely affects postural stability (Randall, 1992).

Carlisle (1998) addressed the physiological effects of exposure of broilers in transport containers to vibration regimes of the frequencies predominating in commercial transporters and proposed that vibrations occurring on commercial broiler transporters can induce a number of conspicuous physiological responses, which may contribute to transportation stress experienced by broiler chickens in transit to slaughter. The author observed that significant treatment effects in plasma CK activity, glucose and corticosterone concentrations indicated induction of physiological stress by exposure to vibration, resulting in muscle damage, hypoglycaemia and activation of the pituitary-adrenocortical axis.

In a recent paper, it was studied the combined effects of mechanical stress (vibration) and heat stress, using the same passive-avoidance, operant-conditioning technique system of choice to measure the aversion of chickens and although it has not identified significant interaction between the tested stressors, is highlighted that other combined conditions can be taken as aversive (Abeyesinghe et al., 2001).

There is no lack of evidence that the vibration affects negatively the welfare of the chicken. This study aimed to evaluate the influence of two different vibration levels on rectal temperature and weight loss, in relation to four turns of exposure to vibration in simulated conditions of transport, based on data from field and analyzes the results comparing it with literature references.

Material and Methods

A trial was carried in a poultry transporting truck, belonging to a slaughterhouse located in the State of São Paulo, Brazil. Therefore, it was used a three-channel acceleration data logger (HOBO Pendant G Acceleration Data Logger, Onset, with measurement range of ± 3 g or 29.4 m/s^2), screwed inside the cage – to maintain the normal pile up routine of the chicken cages, without falling risk for the logger and with minimal influence of chickens on it. The logger was placed in the last cage, in the upper left rear of the truck’s load. The “x” axis corresponded to the vertical vibration (from feet to head), the “y” axis corresponded to the horizontal vibration from right to left and the “z” axis corresponded to the horizontal vibration from aft to fore. The measurement was made with a frequency of data acquisition of 2 Hz (2 data per second), which corresponded to about an hour and a half of collecting data (90 minutes). The truck traveled fifteen minutes on land road and the remainder (one hour and fifteen minutes) on asphalt road. About 2520 data were collected from the land road and 10300 data were collected from asphalt road. Thus, it could be analyzed the totality of the land road stretch and mostly of the asphalt road stretch, obtaining expressive graphics results in terms of presence of mechanical shock in the analyzed box. However, due to the low sampling rate (2 Hz), the maximum frequency of the signal measured was also very low (1 Hz), according to the Sampling Theorem, as has been reported by Nicoletti, R. (personal communication). Therefore, the frequency data were not used for the discussion of the results.

With the collected data, the average acceleration (RMS) for each one of the three axles could be estimated, beyond the general acceleration (RSS). The root mean square acceleration (RMS) is the square root of the square, in each of the three axles separated, and provides an indication of the severity of vibration in each of these axles. The Root Sum of Squares (RSS) is the square root of the sum of the squares of the three RMS values and provides one measure of the overall vibration which occurs at the measurement point (Randall, Streader and Meehan, 1992) and also is called Sum of Vectors.

Therefore, the vibration in each axle can be given by the formula:

$$RMS_{x,y\ ou\ z} = (a_{x,y\ ou\ z}2)^{1/2}$$

where "a" is the acceleration in one of the three axles of vibration.

And the general vibration is given by the formula:

$$RSS = (a_x^2 + a_y^2 + a_z^2)^{1/2}$$

where "a_x" is the acceleration in the x axle, "a_y" is the acceleration in the y axle and "a_z" is the acceleration in the z axle.

Based on the results obtained in the field, it was proceeded the execution for the experiment in laboratory of the Animal Environment Research Nucleus - NUPEA, Esalq-USP. For the simulation of the vibration, was used a shake table with 11 speeds, that do a random vibration in the 3 axles of measurement of the accelerometers, with more emphasis to the vertical axle.

After mounted, the vibratory platform was calibrated. Three accelerometers were screwed in the internal walls of the box in different points and five minutes of data collection resulted in 600 data points for each speed of the table. These data, for each one of the three axles, were compared and were calculated the general mean for each one of the eleven velocities of the vibratory table, as showed in Figure 1.

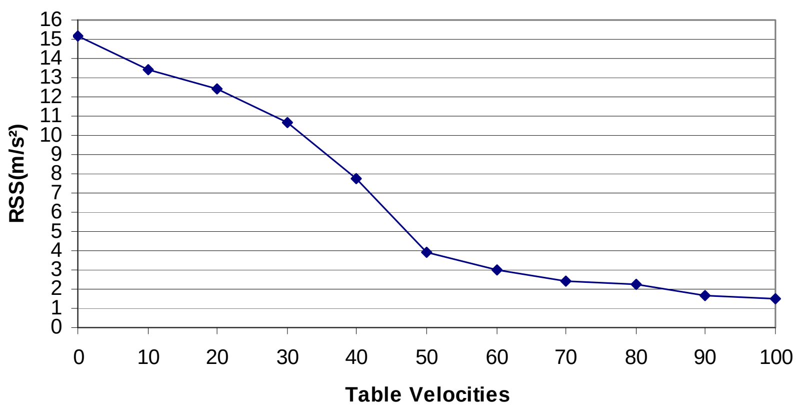

Figure 1 – Sum of Vectors for each velocity of the vibratory table

The speed of the table that would correspond to average sum of vectors that occurred in the truck (speed 60) could be stipulated, beyond stipulating another value of average acceleration for comparison, that did not exceed the 3 g maximum that the accelerometers can measure, what started to occur between speed 30 and 40 of the table, mainly for the vertical axle. So, 40 was the chosen speed.

After calibrated the vibration table, thirty chickens were collected with approximately seven weeks old and 2.5 kg. These chickens were submitted to four hours of feed and water withdrawal in not stressful thermal environment (mean of 23°C of temperature and 52% of relative humidity – measured with Data Logger HOBO ® in the experimental room). Four hours of fast had been considered by Denadai et al. (2002), as being the minimum time to get superior performance when compared with the chickens without withdrawal, without causing dehydration and weight loss.

So the chickens were weighted and separated in three groups: the ones that would only serve as weight, to substitute the ones that were removed of the box to each interval of time (total of six birds); the ones destined to level 1 of vibration (total of 9 birds) and the ones destined to level 2 of vibration (total of 9 birds). The accelerometers again had been screwed inside the box to register the acceleration with the chickens inside the box and confirm or not the calibration. The distribution of the treatments can be observed in Table 1.

Table 1 - Distribution of the treatments according to its respective times and levels of vibration

Time	Levels of Vibration	
	1	2
0	T1 = Control	
30	T2	T5
60	T3	T6
90	T4	T7

For the statistical analysis software SAS 9.1® was used. The test of Tukey was made. Each chicken was considered as being a repetition and each time and level of vibration were considered as being a treatment.

Results and Discussion

With the field data, graphics could be done and it can be observed the existence of shocks for the entire journey, in the two types of road. The shocks can easily be identified in the measurements as acceleration peaks with bigger amplitude when compared with the overall amplitude of the graphic, as mentioned by Nicoletti, R. (personal communication). In the land road, it was observed greater concentration of shocks in the end of the period (Figure 2), suggesting that the road was not homogeneous and/or the driver used different speeds during the period, what, directly/indirectly, cause different consequences to the chickens (Randall, 1993; Randall, 1996; Randall, 1997; Carlisle, 1998). It is also observed that the number of shocks of the asphalt road is lesser, when comparing Figures 2 and 3, considering that more data was taken during this period (Figure 3). If considered as shock only the values above 5 m/s^2, it was found 13 shocks in 15 minutes in the land road (Figure 2), resulting in an average of 0.86 shocks per minute; and in the asphalt road it was found 23 shocks in 75 minutes, resulting in an average of 0.30 shocks per minute. However, is in the asphalt road that is observed the shocks with the biggest amplitude (peaks of ± 10 m/s^2), probably because in the asphalt road the driver was faster and, then, braked/accelerated/turned more brusquely, resulting in these elevated values of acceleration.

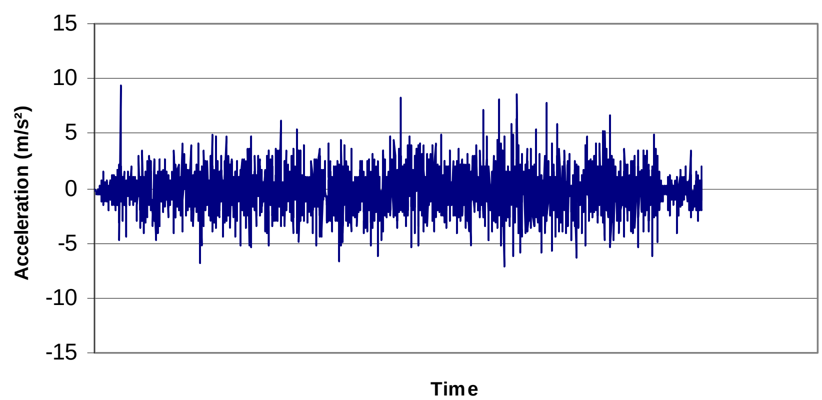

Figure 2. Vertical vibration in land road.

In the Figure 4, is more evident that the asphalt road presented less vertical RMS (1.13 m/s^2) when compared with the vertical RMS in the land road (1.47 m/s^2). However, when these values are placed in the table of acceleration RMS derived from the weights of the frequencies for the broiler chickens, according to Randall et al. (1997) both the values are considered from "aversive" to "very aversive”.

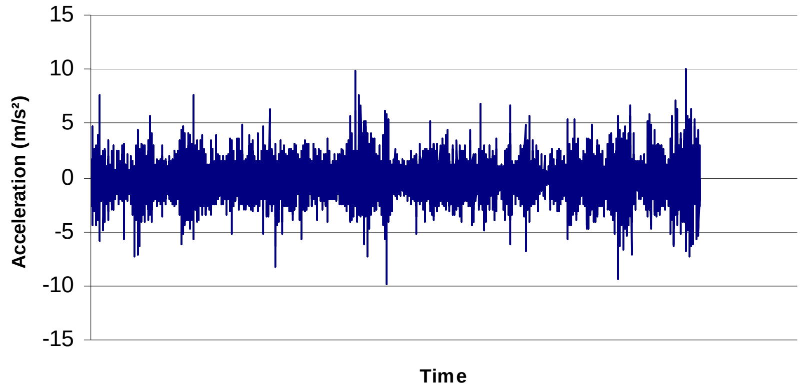

Figure 3. Vertical Vibration in Asphalt Road.

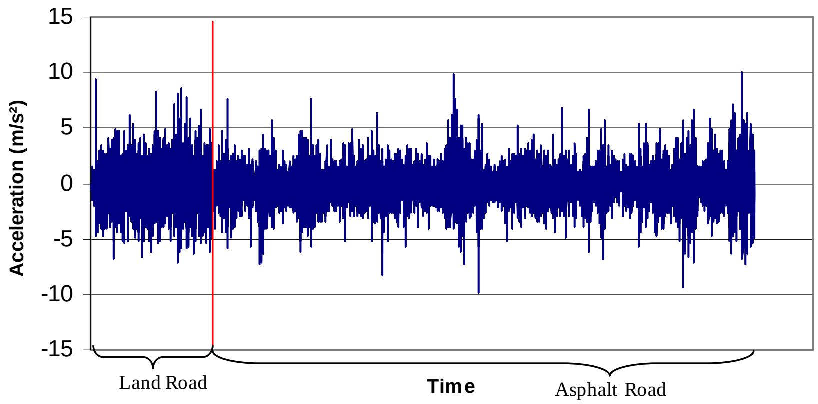

Figure 4. Vertical vibration (entire journey).

In the simulation, the RSS of acceleration in level 1, average of the three accelerometers placed in the box, was 8.7 m/s^2, being considered, therefore, the general acceleration that the chickens had been submitted in level 1. The RSS of acceleration in level 2, average of the three accelerometers placed in the box, was 22.2 m/s^2, being considered, therefore, the general acceleration that the chickens had been submitted in level 2. Both values are predicted as "extremely aversive", according to Randall et al. (1997). Considering that the walls of the cage, where were the loggers, had vibrated equally to the ground, the reactions of the broilers in this work can be compared with the values of aversion measured by Randall et al. (1997). The values of acceleration, in both the levels of vibration tested, did not result in significant changes in Rectal Temperature (RT) for the birds for all the treatments (the average did not varied by the Tukey Test), indicating that the aversion found by the author is not reflected in terms of RT. It can be confirmed by Randall et al. (1995), cited by Perremans et al. (1998), whose reported that was found greater effect of fear in the birds when increasing the frequency (in the range of 5 to 10 Hz) than when increasing the amplitude (in the range of 1 to 5 m/s^2).

Related to weight difference (Initial Weight - Final Weight), non statistical differences were found among treatments, that is, there is no significant difference in interaction broilers weight and time, weight and vibrations level and time versus vibration levels. Concerning studies without vibration effects, Carlisle (1998) did not found differences in the loss of weight between fasting periods of 4 hours and superior periods (8 hours, in the case).

According with results of other studies, it can't be affirmed that the broiler chickens in this experiment were not stressed. Similar analyses using hormonal levels as indicators of stress, combined with RT recording and the vibration frequency can give better information about the influence of different times of exposure and levels of vibration.

Conclusion

Based on the results, it can be concluded that the two levels of vibration used in this experiment and the times of exposition of the birds for the vibration had non significant influence in rectal temperature and weight loss.

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