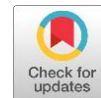



Animal welfare: impacts of pre-slaughter operations on the current poultry industry



Natália Cristina Benincasa ▪ Karina Suemi Sakamoto ▪ Iran José Oliveira da Silva  ▪ Cristian Marcelo Villegas Lobos

NC Benincasa ▪ KS Sakamoto ▪ IJO Silva (Corresponding author)

Department of Biosystems Engineering, University of São Paulo (ESALQ/USP), Av. Pádua Dias, 11, 13418-900, Piracicaba, São Paulo, Brazil.

email: iranoliveira@usp.br

CMV Lobos

Department of Exact Science, University of São Paulo (ESALQ/USP), Piracicaba, São Paulo, Brazil.

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Abstract The pre-slaughter operations are characterized by all the steps after the phase of raising at the farm until hanging of birds on the slaughter line, and this period is relatively faster than the farm phase. Nevertheless, this phase can cause acute stress in broilers, due to the direct handling of the birds at catching and by offering unknown stressful stimuli to the birds during transportation, lairage and hanging on the slaughter line. Other stressful factors such as handling the bird, crating density, impacts on live load, distance and duration of transport between farm and slaughterhouse, and microclimatic conditions in transport and lairage affect the welfare and, consequently, the meat quality of broiler chickens. The effects of these losses will be felt by all sectors of poultry farming. For all these factors, it is important that the poultry production chain be aligned in the near future to meet the external and internal consumers' requirements regarding animal welfare. Therefore, the aim of this review is to address the main critical points, which affect the welfare of broilers during pre-slaughter operations in intensive production systems.

Keywords: broiler production, chicken meat, transport

Introduction

All stages of the intensive poultry production chain can cause some damage to the quality of life and welfare of these animals. Animal confinement during farm phase may cause changes in bird behavior and health due to thermal stress (Schiassi et al 2015), as well as unbalanced nutrient contents in the diet (Carvalho et al 2013), high stocking densities (Campos 2000), among other management errors during poultry production.

Pre-slaughter operations are stressful to birds because of injury, fatigue, deprivation of water and food, which affect the meat quality directly and indirectly (Carvalho et al 2015)

and provokes economic losses to the farmers and poultry industry. European and North American countries have been concerned to understand the path of meat from the farm to their plate and exert pressure on the market and the industries. Despite this, Brazil has a large part of the population that doesn't know how animals are raised and what processes they have gone through until they are available in supermarkets (Bonamigo et al 2012). Therefore, the aim of this review is to address the main critical points, which affect the welfare of broilers during pre-slaughter operations in intensive production systems (Figure 1).

Catching

In the poultry industry, most processes are automated and mechanized, but the process of catching is still carried out manually by workers with a few education and training. The typology of the barns and the infrastructure of the Brazilian farms makes it quite impossible to mechanize this process (Figure 2), while in the United States and many European countries a great number of facilities are totally automated (Pilecco et al 2013).

The mechanical catching leads to a reduction of production costs, less stress and physical injuries to the animals. A significantly lower difference in leg and knee contusions was observed in mechanically catching compared to manual (Lacy and Czarick 1998). Catching is considered one of the most stressful situations in broilers' lives (Elrom 2000) and a significant point of production loss because birds are exposed to high-stress levels and may suffer bruising, scratches and fractures, resulting in carcass depreciation and even death (Queiroz et al 2015). The catching is considered more stressful than transport itself (Ritz et al 2005; Voslarova et al 2011; Vosmerova et al 2010).

The method of manual catching by the bird's back (Figure 2) is recommended by the welfare animal and results in better carcass quality by reducing traumas, although it increases the cost and duration of the process (less efficiency); and the method by neck may cause scratches on the back and thighs, and cause suffocation when introducing the birds into the crates (Leandro et al 2001; Pilecco et al 2013).

According to Schwartzkopf-Genswein et al (2012), there are contradictions about the catching methods which

cause less stress, and which is better for welfare. Although the different catching methods cause different injuries and degrees of severity, the catching method may not be the major impact factor. Langkabel et al (2015), compared two catching methods and concluded that handling the birds with caution is more important than the catch method, because the longer the bird remains suspended in the hands of the catcher, the greater the chances of lesions occur.

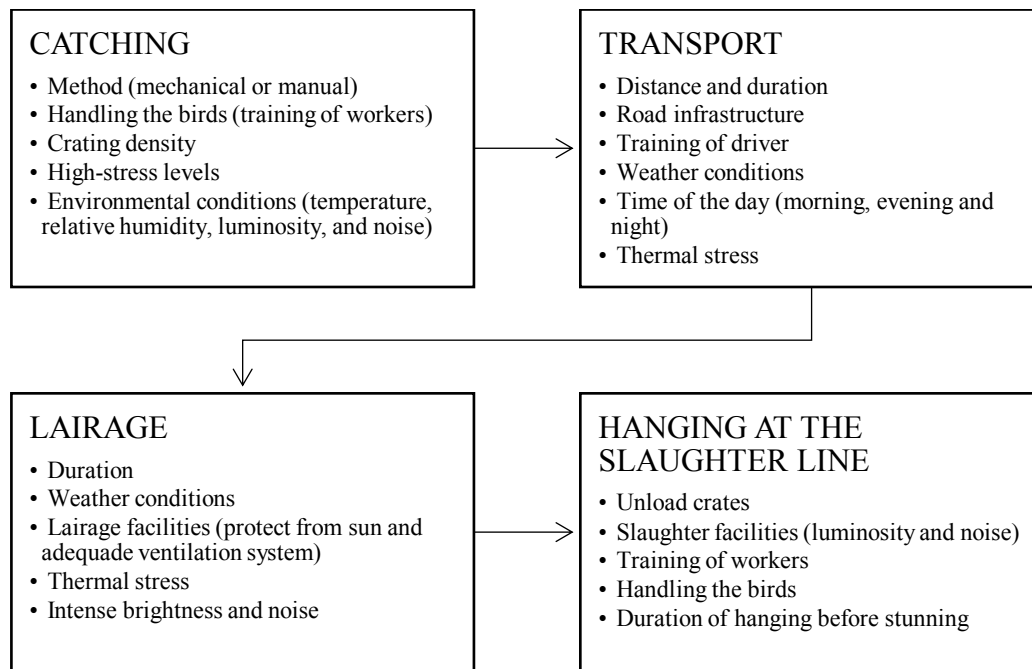


Figure 1 Flowchart of the main factors influencing broilers during the phases of pre-slaughter operations.

The major causes of bruising in the broiler breast are crating the birds quickly through a small opening at the top in the transport crates, and a deregulated mechanical catch system, which places the birds in the transport drawers (Grandin 2015). According to Mendes and Komiyama (2011), 30 to 50% of hematomas occur during catching.

Fractures occurring in conscious birds are painful and compromise welfare. Fractures during the catching and transport are more serious in assessing welfare because they cause prolonged suffering (Kittelsen et al 2015b). During the catching and loading, the employees' ergonomics should be considered as a priority since the human well-being has a direct impact on the animal welfare and the final carcass quality (Carvalho et al 2013; Santana et al 2008).

The aviaries are usually unpleasant places because there is dust and ammonia concentration can be quite high, which can irritate the nasal and ocular mucous membranes of broilers and workers. In addition, it is difficult because the lamps are turned off to reduce the visual acuity of the animals and keep them calm. However, the procedure itself, however

good and fast, also affects broiler chickens health and welfare because of their greater susceptibility to heat stress during and after catching, due to handling (Queiroz et al 2015).

Training of workers involved can reduce the frequency of injuries (Aristides et al 2007). Therefore, continuous training is fundamental when catching crew is composed of young people and workers with little experience (Pilecco et al 2013).

Transport

Throughout the chicken production chain, transportation from the farm to the slaughterhouse is one of the most important sources of stress, especially heat stress (Spurio et al 2016). The microclimatic conditions in the vehicles are the most significant factor and greatest cause of production losses and deaths due to thermal stress (Dadgar et al 2011; Schwartzkopf-Genswein et al 2012; Strawford et al 2011).

Unlike other mild climate countries, the transportation of broilers in Brazil is carried out on a truck that has totally

open sides (Figure 2). In this way, the birds are submitted to climatic weather along the route between farm and slaughterhouse.

Crating density and thermal comfort

Due to the increase of the birds' panting, high densities during transportation influence the mechanisms of thermal exchange, which will be hampered by reduced air turnover in the small space available in the crates and increase the air humidity of the cargo microclimate (Kettlewell 1989; Mitchell and Kettlewell 1994).

The central and rear parts of the truck are the most problematic in terms of air temperature and air relative humidity - presenting high values in both winter and summer - so that they are the most propitious regions to cause production losses (Barbosa Filho et al 2009; Barbosa Filho et al 2014; Mitchell and Kettlewell 1998). The thermal changes due to evaporation are compromised under high temperature and humidity conditions, because the amount of heat lost by broilers will depend on the difference between the aqueous vapor pressure at the evaporation surface of the air as well as the velocity of the air moving on the moist surface (Abreu and Abreu 2011).



Figure 2 Phases of pre-slaughter operations from farm to the slaughterhouse (A and B catching, C transport and D lairage).

Impacts, distance and duration of transport

During the transport act three different types of forces. They are: the "horizontal forces", which derive from the medium to high-velocity curves, of abrupt changes of motion, when a body moves laterally; "vertical forces", which cause a body to move from the bottom up, arising from the normal movements of the suspension of a vehicle and the "longitudinal forces", when the body moves back and forth, derived from the normal braking of the vehicle or due to the unevenness of the road (Walber and Tamagna 2009).

Broilers prefer to be in thermally stressful environments (40°C and 21% relative humidity) than in environments with 2.00 Hz frequency vibration and 1.00 ms⁻² acceleration, demonstrating the aversion of these animals to this type of stressor (Abeyesinghe et al 2001). Later, however, the opposite was demonstrated, indicating that chickens do not

avoid vibration, but significantly avoid thermal stress (Maccaluim et al 2003). Despite the contradictory results, it is notorious that these factors exert negative effects on animal welfare.

The distance traveled, and the incidence of breast bruises and wing fractures are positively correlated, so longer distances cause more injuries, as well as higher densities (Carlyle et al 1997; Costa et al 2007). However, Barbosa Filho et al (2014) found a higher mortality rate in transport at lower distances in the afternoon when compared to long-distance in the morning and evening hours in the summer, demonstrating that the temperature, humidity and season of the year exert great influence in this dynamic.

Increased transport duration is also associated with increased plumage contamination because animals eliminate their excreta and remain in contact with them in crates for a long time before being slaughtered (Jacobs et al 2016a).

Lairage

The birds come to the slaughterhouse physiologically compromised, and the lairage is essential for the thermal re-equilibration of the newly arrived birds of transport (Vieira et al 2010) (Figure 2). At this stage, birds may be exposed to a variety of stressors, such as enclosure confinement, intense brightness, food and water fasting, high crating density and long lairage periods that may lead to increased mortality rates (Bayliss and Hinton 1990). During the lairage period, broiler chickens are submitted to sound stimuli and to a variety of potential stressors, which induce significant increases in blood corticosterone concentration and may increase the mortality rate (Grilli et al 2015). Also, some authors suggest that if the lairage area is heated, the increase in lairage period will contribute to the reduction of the rectal temperature of broilers, and the lairage period should be longer than 2 hours for animals transported over short distances and less than 1 hour for those transported over distances greater than 50 km, to improve the welfare of these animals (Vieira et al 2010). It was observed by Silva et al (2007) that the duration of exposure to high temperatures and relative humidity significantly influenced the rectal temperature of broilers and the respiratory rate.

Dead on arrival (DOA)

It expresses the mortality that occurred during the pre-slaughter period and represents a significant economic loss in the poultry industry, considered as an indicator of bird health and welfare (Chauvin et al 2011; Jacobs et al 2016b).

DOA can be influenced by strain, health, and aspects of the pre-slaughter period, such as catching method, crating density, climatic conditions, transport conditions, transport duration, distance traveled and lairage conditions (Chauvin et al 2011; EFSA, 2012; Jacobs et al 2016b; Vieira et al 2011). It could be used as a first factor and rapid screening of animal welfare in the pre-slaughter period under commercial conditions. Deaths can occur during any of the pre-slaughter stages; however, deaths are not only a consequence of pre-slaughter stages but also farm conditions (Chauvin et al 2011).

The most frequently pathological lesions found in the literature are infectious diseases, cardiovascular disorders, and traumas (Nijdam et al 2006). Wing fractures are the most common postmortem findings in broilers (Gregory and Austin 1992; Nijdam et al 2006), but pre-existing diseases such as osteomyelitis and ascites also have importance (Kittelsen et al 2015a). Other factors have been identified as the most common causes of death in broiler chickens during the pre-slaughter phase, such as sudden death syndrome and traumatic injuries in general, including fractures and ruptures of the liver (Kittelsen et al 2015b). Infectious diseases and heat stress, in

turn, are also important causes reported in the literature (Bayliss and Hinton 1990; Nijdam et al 2004; Ritz et al 2005).

The method of catching is another factor impacting DOA, mechanical catching being more associated with a high DOA rate than manual catching and considered deadlier in several studies (Chauvin et al 2011; Knierim and Gocke 2003; Nijdam et al 2005; Vizzier-Thaxton et al 2006).

Crating density is related to the increase in DOA. High densities favor thermal stress (hyperthermia) caused by increased humidity in the environment and insufficient ventilation rate (Nijdam et al 2004). Low densities may be associated with the generation of lesions in birds (Chauvin et al 2011). Post-mortem evaluations of birds, which died at the slaughterhouse, revealed that 40% of the birds died from thermal stress due to uneven ventilation in the truck and failures of bird's thermoregulation (Kettlewell et al 2000).

According to Schwartzkopf-Genswein et al (2012), most studies associate long-term transport with high bird mortality (Nijdam et al 2004; Vecerek et al 2006; Vieira et al 2011), while the experiment of Vosmerova et al (2010) showed that short-duration transports may be more stressful for birds because they do not have enough time to recover from handling-induced stress during catching and crating, which is the most stressful source of all the process.

In general, there is no optimal duration for lairage to ensure consistently low mortality rates. The duration of lairage does not affect DOA rate since the climatic conditions of the lairage environment are controlled and within ranges of thermal comfort (Bianchi et al 2005; Vieira et al 2011). On the other hand, Silva and Vieira (2010) affirm that acceptable values of mortality should be between 0.10 and 0.50%, while for Grandin (2009) a percentage of 0.50% is considered as "acceptable" and 0.25% as "excellent".

Hanging at the slaughter line

At the loading platform, the slaughter line should be positioned to cause the least possible disturbance to birds (Grilli et al 2015), and should remain between 12 and 60 seconds hanging before stunning (Bedanova et al 2007), to avoid stress, reduce wing injuries, and consequently injuries such as wing fractures, bruises on the carcass, haemorrhages, bruises on the thighs, scratches on the back and thighs (Jones and Satterlee 1997; Mendes and Komiyama 2011).

Identification and classification of injuries

Although the broiler genetic strains have evolved significantly, broiler chickens do not have a skeleton compatible with their weight and bone structure ends up receiving an overload. Thus, even if pre-slaughter operations are carried out properly, many birds will have lesions such as fractures and bruises. Despite this, injuries have different

levels of severity. In order to have a sense of their impact, the measurement of lesions through scores is an important tool already widely used in scientific circles.

There is a wide range of lesions scores available for various parts of broiler body, however, the Welfare Quality protocol for broilers is the one, which brings complete information about the welfare measurement, because it suggests divisions in categories based on severity, such as assessment scores of plumage cleaning, hock burn, and footpad dermatitis.

Broilers' agitation can cause hemorrhagic lesions in the limbs, which will be a production loss at the end of processing. In addition, when agitated birds will flap their wings, raise dust and may disseminate spores which will contaminate the carcass (Vegro and Rocha 2007). The hanging is performed manually and requires training, technique, and supervision to be well done and to avoid the generation of bruises on the carcass. It is necessary that the height of workers in the hanging area is similar, so not influence the pressure imposed on the bird during their placement in the line, which can also cause leg injuries (Vieira 2012).

As well described in this topic, broiler chickens are greatly affected by the conditions under pre-slaughter operations take place. All of them have limitations that must be identified and the best management to minimize stress and production losses. This must be in accordance with the goals of the producers and company because the profits from the final product impact them directly.

Final considerations

Injuries and harm to bird welfare should be studied together, as they may be related and cause damages in later stages, helping to track and prevent these production losses along the poultry chain. The pre-slaughter period may affect bird welfare in different aspects and levels of severity since each stage of this period may be harmful and have a degree of influence. Therefore, it is important to develop indicators for the rapid identification of multiple problems and control of production losses in modern poultry farming.

Conflict of Interest

The author declare no conflict of interest.

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