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Animal welfare during transport and slaughter of beef cattle

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ABSTRACT

Objective: To review how transport and stunning of cattle affect animal welfare.

Approach: During the transport of beef cattle to slaughter plants, several factors affect animal welfare, such as travel time, stress, and load density. Additionally, the correct stunning of cattle helps comply with the animal welfare guidelines established by different protocols such as Welfare Quality®.

Study limitations/Implications: Meat quality is affected by several factors, being of utmost importance the way animals are transported to the slaughterhouse, and they are stunned. Therefore, it is critical to perform these stages properly to obtain good quality meat; besides, it is a welfare issue.

Conclusions: It is critical to comply with transport and slaughter procedures that guarantee good beef meat quality and ensure animal welfare to avoid stress in cattle as possible.

Keywords: Beef cattle, loading density, stress, animal welfare, stunning.

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INTRODUCTION

Red meat is part of the human diet worldwide since it provides good quality proteins (McNeill and Van Elswyk, 2012) and minerals such as iron (Kongkachuichai *et al.*, 2002).

After fattening, bovines are transported for slaughter. Transport can be stressful for the animals, affecting their well-being (Romero *et al.*, 2010; Van De Water *et al.*, 2003), which manifests in the meat, like an increase in pH (Gallo *et al.*, 1998), decrease in muscle luminosity (Gallo *et al.*, 2003), and presence of lesions when using inappropriate vehicles (Huertas *et al.*, 2010). All these represent economic losses for the meat industry (Mach *et al.*, 2008). Therefore, it must be ensured that the animals are transported under animal welfare conditions to obtain better meat quality.

Animal Welfare

Animal welfare or well-being is defined in different ways. Broom (1986) defines "the welfare of an animal and its state as regards its attempts to cope with its environment." The World Organization for Animal Health (OIE) states that animal welfare "is an animal's physical and mental state with the conditions in which it lives and dies". It also mentions that an animal must be healthy, well-fed, safe, protected, in addition to having proper and humane handling at the time of slaughter (OIE, 2011). Different protocols have been developed as the one established by Welfare Quality®, designed to integrate animal welfare into the food chain (Welfare Quality Network, 2009).

Transport and animal welfare

During the transport of beef cattle, factors such as load density (Gallo *et al.*, 2005), travel time (Gallo *et al.*, 1998), experience and attitudes of the driver (Valadez *et al.*, 2018), vibrations, and road conditions (Gebresenbet *et al.*, 2011), type of vehicle used, and environmental factors, can affect animal welfare (Schwartzkopf-Genswein *et al.*, 2016).

Animal transport requires trained personnel. Animals are to be protected from the weather. Upon arrival at the slaughterhouse, they must be provided with good quality water and forage and comfortable and clean pens with an area of 3 m^2 per animal for resting (OIE, 2011; FAO, 2004). Electric prods should not be used for herding, the vehicle must have good ventilation, and overcrowding should be avoided.

Load density and travel time

The allocation of sufficient space for animals during transport should be considered a code of practice and regulation to guarantee the humane treatment of animals (Whiting, 2000). It is necessary to use vehicles designed to transport them properly to avoid injuries and the stress caused by the movement of the vehicle (Santurtun and Phillips, 2015), which can increase blood cortisol levels (Leme *et al.*, 2012).

Load density is the available space that the animals have when transported and is expressed in kg of the animal per m^2 or m^2 per animal. The FAO establishes average load rates for the transport of adult beef cattle by land of 1.0-1.4 m^2 per animal of floor area for beef cattle (FAO, 2001a). The European Union establishes in its regulations for the protection of animals during transport load densities for the transport of bovines according to their weight (Table 1). The same is true in countries such as Australia and New Zealand, which have regulations to determine load density.

Petherick and Phillips (2009), by means of an allometric equation, calculated the space necessary for the transport of livestock. For animals that remain standing during the journey, they determined an area of (m^2)=0.020 W0.66 of the animal, and for animals that are allowed to lay down during the journey, it is given by the equation:

$$\textit{area}\ (\mathrm{m}^2) = 0.027\ W 0.\ 66$$

where: *W* is the LW of the animal.

Table 1. Load density established by different countries.

Department of the Local Government and Regional Development of Western Australia (2003)		European Union (2005)	
Cattle body weight (kg)	**Floor area (m^2/ animal)**	**Cattle body weight (kg)**	**Floor area (m^2/ animal)**
250	0.77	50	0.30-0.40
300	0.86	110	0.40-0.70
350	0.98	200	0.70-0.95
400	1.05	325	0.95-1.30
450	1.13	550	1.30-1.60
500	1.23	>700	>1.60
550	1.34		
600	1.47		
650	1.63		

Broom (2008) recommends that for a 500 kg LW bovine, with a route of less than 12 h, a floor area of 1.35 m^2 should be assigned, and if the route is longer than 12 h, the floor area should be 2.03 m^2.

In Mexico, beef cattle are generally transported from feedlots to slaughter plants in potbelly cages (Figure 1), loading 45 to 50 bovines per cage, weighing 550-700 kg LW, and a travel time that ranges from 1-15 h. Moreover, livestock traders have chosen to have personnel dedicated exclusively to the loading and unloading of livestock as a strategy to reduce the stress caused by this activity.

Teke *et al.* (2014) carried out a study in Turkey, transporting Simmental beef cattle over a distance of 1800 km, with a load density of 2.8 m^2 per animal, with a resting time before slaughter of 24, 48, and 72 h. The authors concluded that after a prolonged transport, it is necessary to rest the animals for 72 h since this shows better pH 24 values in the meat (5.48). In a study conducted by Gallo *et al.* (2005), they surveyed two regions of Chile, where load densities fluctuated between 457 ± 6.6 kg/m^2 and 453 ± 9.7 kg/m^2. The authors

Figure 1. Transport and unloading of cattle at the slaughterhouse (Image of the authors).

observed that if the travel distance was long, the load density increased, exceeding that allowed by the country's legislation, which is 500 kg/m^2, resulting in more significant stress in the animals and a high incidence of muscle contusions.

Factors such as the absence of loading and unloading facilities, transporting animals on hot days, and the stress caused during cattle slaughter can cause depletion of muscle glycogen having low postmortem lactic acid production, which results in a high pH of the meat (Mounier *et al.*, 2006). Therefore, it is necessary to transport and unload the cattle in the mornings without extending the rest period for more than 4 h before slaughter in hot seasons (Pérez-Linares *et al.*, 2015).

Stunning and slaughter

Effective stunning can be defined as rendering the animal unconscious or insensitive to pain immediately. The physical signs are that the animal collapses, does not breathe rhythmically, and has no corneal reflex, a relaxed jaw, and a hanging tongue (HSA, 2016). Likewise, some authors have used other signs to assess animals' stunning, such as floppy heads and blank stares. There is often limb movement after stunning, but it is not considered a sign of a return to sensation (Grandin, 1998). There are different stunning methods, mechanical such as a captive bolt, electrical, gas, and others such as lethal injection and puntilla. The captive bolt and puntilla are the most used to stun beef cattle in Mexico.

Captive bolt

The primary function of stunning cattle with a penetrating captive bolt, or stun gun, is to cause a forceful and irreversible concussion (Gregory *et al.*, 2007).

The device (Figure 2) consists of a trigger or contact-operated pistol containing a bolt or projectile, which is propelled by the detonation of a cartridge or compressed air (FAO, 2001b).

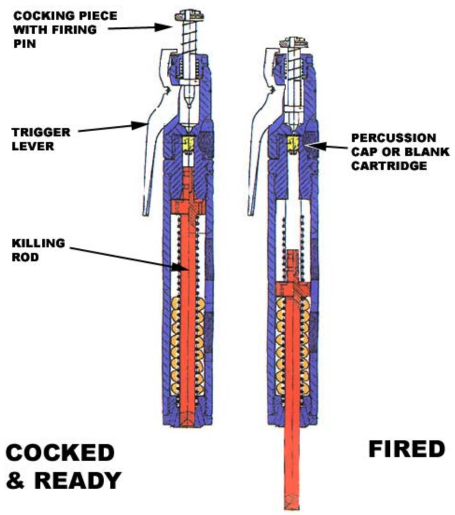

Figure 2. Penetrating captive bolt (Firearms History, Technology & Development, 2011). Firearms History, Technology & Development. (2011). Utility Firearms: Meat Processing Industry, March 11, 2011. http://www.firearmshistory.blogspot.com/2011/03/utility-firearms-meat-processing.html

The device penetrates the skull, producing a concussion by injuring the brain or increasing intracranial pressure (Gregory *et al.*, 2007), causing internal cerebral hemorrhage (Atkinson *et al.*, 2013), followed by a tonic phase or contraction of the extremities lasting from 10 to 20 seconds. Subsequently, there is the clonic phase or involuntary movement of the extremities, which gradually decreases. Otherwise, if an animal sign kicking or row when collapsing, it indicates that it did not receive a correct stun (HSA, 2016).

The functionality and effectiveness of the captive bolt depend on several factors, like the animal's breed and the length of the captive bolt. Martin *et al.* (2018) indicate that Holstein breed animals present more significant limb movement activity than zebu breed animals. Furthermore, animals stunned with a 15.24 cm long bolt tend to present more movements in the slaughter track.

The accuracy and direction of the shot are critical in determining the efficiency of the stun. The Scientific Panel on Animal Health and Welfare (AHAW) recommends that for a good stunning, the shot (Figure 3) should be placed at the crossing point of imaginary lines drawn between the base of the horns and eyes, not exceeding a radius greater than 2 cm from this point (AHAW, 2004). Thus, the imprecise use of the stun gun could affect the stunning efficiency. Therefore, evaluating the impact points and the firing direction can be taken as standards for stun control (Fries *et al.*, 2012).

Some authors attribute the failure to stun animals with captive bolts to the operator's lack of experience, gun maintenance, and cartridges storing in humid places. Animal's size is also crucial because they have thicker skulls that are more difficult to penetrate, the caliber of the cartridge used, and the frequency of use of the gun (Gibson *et al.*, 2015; Grandin 2002).

Puntilla

Published information about stunning with a puntilla is limited. The OIE does not have the puntilla method approved because it is considered an ineffective and inhumane method of animals' slaughter (OIE, 2011).

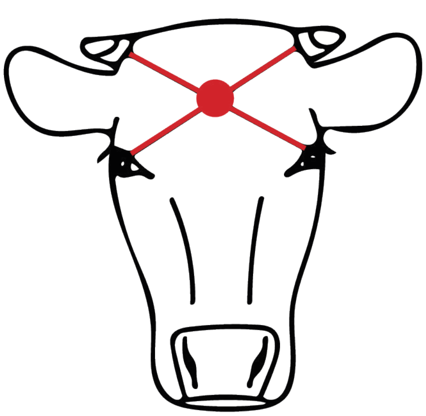

Figure 3. Shot position with a penetrating captive bolt (HAS, 2016).

Limon *et al.* (2009) examined the puntilla method applied in llamas (n=20), where they reported that in 45% of the cases, it was necessary to repeat the stunning and 95% of the animals presented palpebral reflex, concluding that it is difficult to achieve a good stunning with a single puntilla stab (Limón *et al.*, 2009).

In another study, the application of puntilla was evaluated in beef cattle (N=309), reporting that it was necessary to repeat the stunning in 24% of the animals, occurring more frequently in heavier animals (>380 kg), concluding that the nerves often remain functional after stabbing 8. (Limón *et al.*, 2010). Therefore, it is very likely that the animals are still conscious during slaughter.

There are no evaluations about the brain and spinal cord activity after using the puntilla. Therefore, it is necessary to determine a strategy to use an effective method for stunning humane and accessible to use daily in slaughterhouses (Limon *et al.*, 2012). Other factors must be considered, such as sex, breed, animal live weight, body condition, and the operator's experience.

CONCLUSIONS

The beef production system must consider procedures that guarantee the welfare of the animals during the transfer from the feedlot to the slaughterhouse since it can be very stressful for the animals. The load density, travel time, and how animals are slaughtered play an essential role in the meat production chain. Currently, in Mexico, studies related to animal welfare are beginning to be carried out during the transport and slaughter of beef cattle, trying to determine the critical points that generate more stress in the animals.

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