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Swine welfare at slaughterhouses in Valle de Aburrá (Colombia)

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ABSTRACT

The World Organization for Animal Health (OIE) makes recommendations related to the slaughter of animals for human consumption. Colombia has some regulations on animal welfare in slaughterhouses. This study assessed welfare of pigs in slaughterhouses in Valle de Aburrá, Colombia using measures from existing welfare protocols (Welfare Quality: Assessment protocol for pigs; Recommended Animal Handling Guidelines and Audit Guide for Cattle, Pig and Sheep).

The objective was to determine the degree of compliance with some welfare protocols recommendation (Welfare Quality. Assessment protocol for pigs and Recommended Animal Handling Guidelines and Audit Guide for Cattle, Pig and Sheep) in regards to welfare of pigs in slaughterhouses in Valle de Aburrá, Colombia.

A cross-sectional study was conducted using data from four slaughterhouses during 2017. Univariable analysis was performed, depending on the type of variable. Frequency distribution was assessed for descriptive variables, while quantity variables were assessed by central tendency and dispersion measures.

It was found that electric prods are often used for moving pigs to lairage pens and to stunning area, the animals remain in lairage pens in too high stocking densities and also some signs related to inadequate loss of consciousness during stunning were shown. Some pigs were kept more than 10 h in lairage pens and some did not have access to water. Skin lesions occurred in 93.6% of the observed animals.

It is concluded that the assessed slaughterhouses do not manage to keep animal welfare on a required level.

1. Introduction

Animal handling prior to slaughter is one of the most stressful circumstances for pigs (Averós, Knowles, Brown, Warriss, & Gosálvez, 2008; Warris, 1994; Warriss, 2003). Several protocols are available to assess animal welfare in slaughtering plants. The " Welfare Quality® assessment protocol for pigs ", developed by The European Welfare Quality Project, and the "Recommended Animal Handling Guidelines and Audit Guide" developed by the American Meat Institute/Animal Welfare Committee are among such available protocols. Those protocols have been developed to evaluate and control the quality of animal welfare both in farms and slaughterhouses. Abattoir protocols comprise a set of observations used to evaluate animal welfare during the different stages of transit, such as truck downloading, lairage in holding pens, on the way to stunning and during stunning.

The World Organization for Animal Health (OIE) issued recommendations on, for instance personnel training, ethology, suppression of distractions like reflections on wet floors, dark entrances to ramps, corridors, stunning compartments or immobilization corridors, movement of people or material in front of animals: uneven floors, restraint and containment of animals, design of facilities, animal care, stunning and slaughtering methods to ensure welfare during slaughter of animals for human consumption (World Organization for Animal Health, 2016). Colombia has some regulations in slaughter plants, like Decree 2278 of 1982 which includes issues related to stunning methods, lairage, and emergency slaughtering; Decree 1500 of 2007 and resolutions 240, 241 and 242 of 2013, include directions to guarantee animal welfare in abattoirs (Instituto Colombiano Agropecuario ICA 2007; Ministerio de la Protección Social. 2007). The objective of this study was to establish the level of compliance with welfare protocols in slaughtering plants of Valle de Aburrá, Colombia during 2017.

2. Material and methods

This study was conducted during 2017 at four abattoirs approved by the Colombian national institute for food and drug surveillance (INVIMA) in Valle de Aburrá. Probabilistic sampling -stratified per abattoir was used to select the animals for analysis. The study was endorsed by the ethics committee for the use and care of animals (CICUA) of CES University (Medellin, Colombia), as stated in Act

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Table 1
Kappa global index for every measures.

Number of pigs:	25			
Number of observers:	5			
Confidence interval:	95.00%			
			Significance test	
Category	Kappa	IC (95,0%)	Statistical Z	*P* value
Falls Kappa global	0.90	0.79–0.98	5.976	< 0.001
Slips Kappa global	0.75	0.58–0.84	7.654	< 0.001
Vocalizations Kappa global	0.84	0.74–0.92	7.654	< 0.001
Panting Kappa global	0.76	0.62–0.87	9.308	< 0.001
Huddling Kappa global	0.94	0.89–0.97	9.895	< 0.001
Stunning time Kappa global	0.92	0.89–0.97	1.113	< 0.001
Postmortem lesions Kappa global	0.76	0.72–0.82	15.66	< 0.001

number 14 of 2015.

Five observers were trained by a veterinarian who has more than 10 years working experience in pig's welfare field. A pilot test was conducted using another slaughterhouse with similar characteristics. The pilot test was conducted using 25 pigs. Likewise, Kappa index was obtained for every measure to determine the grade of concordance between observers (Table 1).

2.1. Selection of animals

Sample size calculations took into account the average number of pigs slaughtered monthly in Valle de Aburrá. We used the formula for finite populations. We considered a 5% expected error, with 95% confidence level, 34% expected prevalence for the incidence of pale, soft and exudative meat (Castrillón, Fernández, & Restrepo, 2007). The sample was expanded by 10% to control possible losses of information (e.g. pigs that died without having observed them during the whole process). At the end, information from 451 animals was gathered. Sample size was estimated with Epidat (version 3.1) statistical program.

Pigs were selected through systematic random sampling. Each slaughterhouse was visited 5–6 times per month and during each visit we selected between 20 and 30 animals for analysis. The sampling fraction K = N/n (average pigs per month per each slaughterhouse/sample size) was used to determine the sampling interval required. The first animal was selected randomly, using a random number table. After that, we selected the next animal based on the sampling interval. We counted pigs always from left to right, beginning from the most proximal container box to the driver´s cabin and always starting on the top floor. When there were no more pigs on the top floor, we used the same sampling procedure on the bottom floor of the truck.

2.2. Animals

Selected animals were observed in the slaughtering plants. Animal behavior (walking, slips, falls, vocalizations, panting, huddling), facilities and management (mechanism to moving from lairage to stunning) were monitored every half hour for 15-min periods. Selected pigs were marked with an ID number using permanent marker. Pig IDs were checked before stunning.

2.3. Variables

Variables were assessed in each stage of pig conduction through the slaughtering plant (unloading of animals from trucks, conduction to holding pens, lairage, conduction to the stunning area, and exsanguination). Next, variables and methods for obtaining the information in each stage are described.

2.4. Unloading

Animal behavior was assessed to evaluate response to handling (percentage of pigs that refuse to move), and thermal comfort (percentage of pigs that exhibited panting) according to Welfare Quality® assessment protocol for pigs. Occurrence of slipping or falling of the selected animals was observed during driving from the unloading ramp to the lairage pens. Slips were assessed according to the percentage of pigs whom loss of balance, while falls were assessed through the loss of balance with part of the body other than the limbs in contact with the floor according to Welfare Quality® assessment protocol for pigs.

2.5. Pens

Behaviors related to thermoregulation were evaluated. Those behaviors included huddling (percentage of pigs that were touching more than 50% of its body with on top of another pig when resting), panting (percentage of pigs that exhibited panting inside the lairage pens, 30 min after unloading from the truck), and vocalizations during the stay in lairage pens. Pen dimensions, number of animals per pen, availability and condition of the drinking water system, slips and falls were also recorded according to Welfare Quality® assessment protocol for pigs.

Vocalization was assessed as follows:

- Low: (0 to 1 vocalizations/15 min)
- Medium: (2 to 5 vocalizations/15 min)
- High: (> 5 vocalizations/15 min)

The stocking density was classified based on Colombian regulations and was considered low density (more than 1.10 m^2/100 kg), adequate density (between 1.0 and 1.10 m^2/100 kg) and high density (less than 1.0 m^2/100 kg). Animals were also observed during their transit towards the stunning area to record slips, falls, and moving procedures used (flags, slaps, shouts, electrical prod). The use of electrical prod was calculated and classified according to the Recommended Animal Handling Guidelines and Audit Guide, considered excellent 10% percent or less, acceptable 25% percent or less, not acceptable more than 25% and, serious problem 50% or more.

Thus, percentage of falling and slipping pigs (%), was calculated and classified according to the Recommended Animal Handling Guidelines and Audit Guide. Slips were considered less than 5% as excellent; less than 10% acceptable, more than 10% as a not acceptable and more than 25% as a serious problem. On the other hand, falls were considered no falling as excellent; less than 5% acceptable; more than 5% not acceptable and more than 10% as a serious problem.

2.6. Effectiveness of stunning

The stunning method used, the time it took (time inside the CO_2 chamber or time that electrical current was used), and the time between stunning and slaughtering were recorded. The level of consciousness of the animal was assessed by evaluating the presence of corneal reflex, rhythmic breathing, righting reflex, and vocalizations.

2.7. Postmortem lesions

Postmortem lesions were organized according to macroscopic appearance (coma-shaped, rectangular, linear, rhomboid, diffuse, hematoma and petechiae) and the anatomical region affected (head, back, loin, medium and ham). The average size of dermal lesions was categorized as (≤0.5 < 1.99 cm); (≤2 < 5 cm); (≤ 5.1 < 10 cm); (≤ 10.1 < 15 cm) or larger than 15 cm (Varón-Álvarez, Romero, & Sánchez, 2014).

Table 2
Handling and behavior of pigs during unload at abattoirs.

Variable	Category	Frequency (n = 451)	Percentage %
Driving to lairage pens	Use of Electric goad	30	6.7
	Use of flags	50	11.1
	Slapping	214	47.5
	Shouting	157	34.8
Panting	Yes	75	16.7
Slips	Yes	152	33.8
Falls	Yes	83	18.5

2.8. Statistical analysis

Univariable analysis was performed, depending on the type of variable. Frequency distribution was assessed for descriptive variables, while quantity variables were assessed by central tendency and dispersion measures. The statistical analyzes were conducted using Epidat 3.1 and SPSS (version 21) programs.

3. Results

During truck unloading at the abattoir, electric goads were used in 6.7% of the animals. Likewise, 16.7% showed thermoregulation difficulties expressed by panting, and 18.5% animals fell in the process (Table 2).

In lairage pens, 9.8% of the animals stayed more than 10 h, while 36.6% were kept overcrowded, and 12% had no access to water (Table 3). Similarly, 19% of the pigs showed thermal discomfort expressed either by panting or huddling, and 34.1% produced high number of vocalizations during the stay, as shown in Table 4.

Regarding to stunning, 75% of the times it was performed by either head-head or head-heart electric stunning. In terms of its effectiveness, on average 9.2% of the animals attempted to regain a standing position after stunning (Tables 5 and 6).

Finally, 93.6% of the animals presented some type of postmortem injuries. Lesion size was between 5.1 and 10 cm in the loin, and 10.1–15 cm in the ham, respectively (Table 7).

4. Discussion

During truck unloading at the abattoir, ease of movement can be assessed by the percentage of animals that slip and/or fall, which is mainly associated with inadequate facilities or driving to lairage pens (Grandin & Chambers, 2001a). In this study, on average, 33.8% of pigs slip and 18.5% fell, which is much higher compared to reports from European (Spanish and Italian) and Brazilian slaughter plants, which average 2.1% falls and 13.9% slips, respectively (Dalmau et al., 2016).

Table 3
Pig handling during lairage in abattoirs.

Variable	Category	Frequency (n = 451)	Percentage %
Lairage time	Between 4 and 6 h	275	61.0
	Between 6 and 10 h	132	29.3
	More than 10 h	44	9.8
Availability of drinking water in holding pens	No	54	12.0
Stocking density	Low	83	18.4
	Adequate	203	45.0
	High	165	36.6
Driving to stunning area	Use of electric goad	21	4.7
	Use of flags	74	16.4
	Slapping	219	48.6
	Shouting	137	30.4

Table 4
Pig behavior in holding pens.

Variable	Category	Frequency (n = 451)	Percentage %
Huddling	Yes	51	11.4
Panting	Yes	34	7.6
Slips	Yes	131	29.0
Falls	Yes	74	16.4
Vocalizations	Low	161	35.7
	Medium	136	30.2
	High	154	34.1

Table 5
Type of stunning.

Variable	Category	Frequency (n = 451)	Percentage %
Stunning method	Electric (head - head)	225	49.9
	Electric (head–heart)	113	25.1
	CO_2 chamber	113	25.1

	Mean	Standard deviation	Median (Range IQR)
Stunning time (s)	47.20	14.09	43.0 (9)
Time between stunning and bleeding (s)	16.13	5.39	15.00 (6)

Regarding thermoregulation, 16.7% animals showed panting despite being transported and unloaded either at night or at dawn, with average temperature ranging between 16 and 20°C ("Hourly Weather for Medellin - AccuWeather Forecast for Antioquia, Colombia (ES)" 2017). These numbers differ from Brazilian and Canadian reports, where panting was only 8% and 0.6% respectively (Dalmau et al., 2016; Rocha et al 2016).

In the holding pens, 18.4% of the animals was housed at low density (more than 1.00 m^2/pig), which could have been associated to a slow flow of animals arriving to the abattoirs. Conversely, 36.6% of the animals were housed at high densities, similar to reports from Portugal, Italy, Finland, Brazil and Spain, in which average density was 0.71m^2/pig (Dalmau et al., 2016). Considering that overcrowding elicits agonistic behaviors (e.g. fights and bites) it is imperative to offer animals enough space to increase comfort when walking to drinking areas or perform exploration behaviors (Rabaste et al., 2007; Velarde & Dalmau, 2012).

In relation to water, there should be a drinker per 10 animals (Welfare Quality. Assessment protocol for pig 2009, Dalmau et al., 2016; Veehouderij, 2009). Although the number of pigs/drinker was not assessed, we observed that 12.0% of the animals did not have access to water, which predisposes to panting at high temperatures (Huynh et al., 2005). Panting in the holding pens was observed in 7.6% of the pigs, which is much higher than that reported in Spain, Finland and Brazil, where panting was 0.16%, 0.17% and 0.33%, respectively (Dalmau et al., 2016). It is known that lack of water during lairage can negatively affect animal welfare generating dehydration which can produce hyperthermia, panting and death (Becerril-Herrera et al., 2009; Brown, Knowles, Edwards, & Warriss, 1999; Schaefer, Jones, & Stanley, 1997).

Huddling behavior (percentage of pigs that were touching on top more than 50% of its body with another pig when they were resting) was observed in 11.4% of the animals in lairage pens, indicating that temperatures were below optimum, which should range between 15 and 18°C (Velarde & Dalmau, 2012). Other studies have reported between 3.76% and 13.0% huddling (Dalmau et al., 2016; Faucitano & Geverink, 2003). According to our results, ventilation and/or

Table 6
Effectiveness of stunning.

Variable	Category	Frequency Electric (head – head) (n = 225)	Percentage %	Frequency Electric (head – heart) (n = 113)	Percentage %	Frequency CO_2 chamber (n = 113)	Percentage %
Corneal reflex	Yes	67	29.7	35	31.0	38	33.6
Rhythmic breathing	Yes	47	20.8	27	23.8	30	26.5
Attempts to regain a standing position	Yes	15	6.6	11	9.7	13	11.5
Vocalizations	Yes	40	17.7	22	19.4	25	22.1

temperature in the holding pens of abattoirs in Valle de Aburrá should be improved taking into account precipitation, environmental temperature, air drafts and daily flow of animals.

Moving of animals through slaughter plants should be free from slips and falls. This can be achieved with non-slip floors in pens and corridors towards stunning areas (Gallo & Tadich, 2008). While slips and falls should not exceed 5% (Grandin, 2010), we observed 29% slips and 16.4% falls. This is an indication of infrastructure deficiencies and animal handling problems (Muñoz, Strappini, & Gallo, 2012).

Proper handling can be further compromised by the use of electric goads inside the slaughterhouse because those devices greatly stress the pigs. The OIE has banned this practice for the handling of horses, sheep and small pigs (World Organization for Animal Health, 2016). Its use is appropriate only when animals refuse to move, lie down, and have no illnesses that impede walking (Manteuffel, Puppe, & Schon, 2004). The OIE approves the use of battery-operated electric goads with a voltage not exceeding 30 V (Grandin, 2001). An “excellent” score is given when used in less than 5% of the cases (Grandin, 2013). In this study, electric goads were used in 6.7% of the pigs driven from trucks to the lairage pens, and in 4.7% of pigs driven from pens to stunning areas. These results are similar to other studies conducted in Colombia, in which excessive use of electric goads has been reported. This is caused by improper design of aisles and lack of knowledge of pig behavior by the handling personnel (Romero P & Sánchez V, 2012). Our results are also similar to studies conducted in Chile and France where excessive use of electric goads has been reported (Bourguet, Deiss, Tannugi, & Terlouw, 2011; Muñoz et al., 2012).

According to Manteuffel et al. (2004), animal vocalizations are indicative of problems related to the equipment or improper handling. Increased vocalizations are related with the use of electric goads, slips, falls, lack of training of staff, nervous animals, and inadequate calibration of stunning equipment (Grandin, 2001; Grandin, 2010; Grandin, 2013; Manteuffel et al., 2004). In our study, vocalization was high, with 34.1% of the pigs vocalizing during the stay in lairage pens, which could be related to mix animals with other unknown animals and the high density that was used in 36.6% of the pigs, increasing agonistic behaviors (e.g. fights and bites) and consequently high vocalization (Rabaste et al., 2007; Velarde & Dalmau, 2012).

Rhythmic breathing is an indicative of inadequate stunning (Grandin, 2013; Terlouw, Bourguet, & Deiss, 2016; Verhoeven, Gerritzen, Hellebrekers, & Kemp, 2015). Respiration should stop after gasification (CO_2 overload/lack of O_2) due to decreased neural activity of the brain and the brainstem. Respiratory arrest should also occur after electrical stunning following propagation of the epileptic attack to subcortical regions (thalamus and brainstem) and some cortical areas (Devinsky, 2004; Verhoeven et al., 2015). We observed rhythmic breathing after stunning at 20.8% when the pigs were stunned by head-to-head electric shocks; 23.8% using head-to-heart electric shocks; and 26.5% using CO_2 chamber.

Corneal reflex is tested by lightly touching the cornea. This reflex involves transmission of sensory information to the brainstem causing a motor response. When present, the eyeball is slightly retracted and the eyelid closes, passing the sensory information via trigeminal nerve (Cruccu & Deuschl, 2000). Corneal reflex is considered reliable to evaluate the state of unconsciousness after slaughter. Any interruption of the underlying neural circuit modifies or removes the reflex. If

Table 7
Skin lesions after pig slaughter.

Variable	Category	Frequency (n = 451)y	Percentage %	Variable	Category	Frequency (n = 451)	Percentage %
General lesions	Yes	422	93.6				
	No	29	6.4				
Head lesions	Coma	118	26.2	Head lesions	Between 0.5 and 1.99 cm	59	13.0
	Linear	5	1.1		Between 2 and 5 cm	75	16.6
	Petechias	24	5.3		Between 5.1 and 10 cm	13	2.9
	Without lesions	304	67.4		Without lesions	304	67.4
Back lesions	Coma	139	30.8	Back lesions	Between 0.5 and 1.99 cm	73	16.2
	Rectangular	42	9.3		Between 2 and 5 cm	98	21.7
	Linear	24	5.3		Between 5.1 and 10 cm	34	7.5
	Without lesion	246	54.5		Without lesions	246	54.5
Loin lesions	Coma	12	2.7	Loin lesions	Between 0.5 and 1.99 cm	9	2
	Rectangular	33	7.3		Between 2 and 5 cm	29	6.4
	Linear	149	33		Between 5.1 and 10 cm	120	26.6
	Rhomboid	1	0.2				
	Diffuse	9	2		Between 10.1 and 15 cm	77	17.1
	Hematoma	31	6.9				
	Without lesion	216	47.9		Without lesions	216	47.9
Side lesions	Rectangular	40	8.9	Side lesions	Between 2 and 5 cm	7	1.6
	Linear	74	16.4		Between 5.1 and 10 cm	111	24.6
	Diffuse	77	17.1		Between 10.1 and 15 cm	191	42.4
	Hematoma	123	27.3		Larger than 15 cm	5	1.1
	Without lesion	137	30.4		Without lesions	137	30.4
Ham lesions	Rectangular	33	7.3	Ham lesions	Between 5.1 and 10 cm	61	13.5
	Diffuse	123	27.3		Between 10.1 and 15 cm	169	37.5
	Hematoma	91	20.2		Larger than 15 cm	17	3.8
	Without lesion	204	45.2		Without lesions	204	45.2

corneal reflex is absent, there is a high probability that the disruption is associated with a more extensive dysfunction, partially including the reticular formation (Cruccu & Deuschl, 2000; Verhoeven et al., 2015; Zerari-Mailly, Dauvergne, Buisseret, & Buisseret-Delmas, 2003). Corneal reflex was present on average of 31.4% of the pigs in our study.

Animals should immediately collapse after effective stunning as a result of damage to the reticular formation, which is involved in the control of standing posture (Purves et al., 2001). Electrical stunning causes immediate collapse due to a convulsion spreading through the cerebral hemispheres and subcortical structures such as the reticular formation (Verhoeven et al., 2015). Gas stunning induces loss of ability to maintain a standing posture probably due to an overall progressive dysfunction of cortical and subcortical structures, including the reticular formation. Posture loss without trying to return to a standing posture has been suggested as a sign of early stages of unconsciousness (Gibson, Dadios, & Gregory, 2015). Our results showed that on average of 9.2% of the animals attempted to regain a standing posture; 6.6% when the pigs were stunned by head-to-head electric shocks; 9.7% using head-to-heart electric shocks; and 11.5% using CO_2 chamber.

Finally, according to our results, 93.6% of the sampled pigs had skin lesions, with loin, ham and middles being the most affected areas, while head and back were less affected. The most common type of skin lesions was hematomas at mid-level, linear lesions in loins, and coma-shaped ham lesions. Other studies in Colombia have also shown a high proportion of skin lesions in carcasses, with up to 100% incidence. They reported that most frequent contusions were localized in the loin (32.0%) and ham (22.0%), with coma-shaped (71.8%), linear and diffuse lesions predominating. Regarding lesion size, contusions between 2 and 10 cm prevailed (57.0%). Likewise, they reported that the back and head were the least affected areas (Varón-Álvarez et al., 2014). Lesions can denote the animal welfare status and are used as a reference during welfare audits. Additionally, lesions observed in abattoirs generate penalizations on the price of carcass (Miranda-de la Lama, 2013) or seizures of tissue parts, limbs, or even complete carcasses by the abattoir authorities (Temple Grandin & Chambers, 2001a, 2001b).

5. Conclusions

Animal welfare at abattoirs in Valle de Aburrá is deficient, since pigs are not offered optimal slaughtering conditions, some of them did not have access to a water supply, others were kept in high density and most of the animals had skin injuries. Likewise, stunning methods are not properly working in these abattoirs. Possible reasons for this are a lack of maintenance of infrastructure, lack of training of the personnel, and inadequate calibration of equipment, among others. More studies are needed to better understand the causes of these problems. Thus, it is important to continue promoting Colombian regulations regarding proper infrastructure requirements, personnel training and calibration of equipment that abattoirs must fulfill for suitable operation in order to ensure animal welfare and quality of the end product.

Conflict of interest statement

None of the authors has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.vas.2018.07.006.

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