

Original Article

Prevalence of carcass bruises as an indicator of welfare in beef cattle and the relation to the economic impact

Stella M. Huertas*, Frank van Eerdenburg[†], Andrés Gil* and José Piaggio*[‡]

*Facultad de Veterinaria, Instituto de Biociencias Veterinarias, Universidad de la República, Lasplaces 1550 CP 11600, Montevideo, Uruguay,

[†]Department of Farm Animal Health, Faculty of Veterinary Medicine, Utrecht University, Yalelaan7, 3584 CL Utrecht, The Netherlands,

and [‡]Unidad de Epidemiología, Ministerio de Ganadería Agricultura y Pesca, Constituyente 1476, CP 11200, Montevideo, Uruguay

Abstract

The objective of this work was to characterize bruises in bovine carcasses in Uruguay and to evaluate the economic impact. Thirteen abattoirs were visited during 2 years and bruises were identified, classified, and quantified by zone and degree (depth and size). One hundred carcasses were separated and bruises were cut out and weighed separately. From a total of 15 157 carcasses observed, 60.0% had at least one bruise; 42.0% of these had bruises on both sides. The expensive butt zone was the most damaged, followed by rib, shoulder and loin, respectively. The mean weight and standard error of the condemned trimmed meat was 1602 ± 212 g. It suppose a loss of 899 g per animal slaughtered in Uruguay. In a country sending 2.5 million heads of cattle to be slaughtered yearly, this indicates an important financial loss. Improving transport conditions and personnel skills will probably result in a better welfare for the animals as well as better financial profit.

Keywords: animal welfare, beef cattle, carcass damage, meat quality, bruises.

Correspondence: Stella M. Huertas, Facultad de Veterinaria, Instituto de Biociencias Veterinarias, Universidad de la República, Lasplaces 1550 CP 11600, Montevideo, Uruguay. E-mail: stellamaris32@adinet.com.uy

Introduction

Economic losses due to carcass bruises are a substantial problem in the meat chain and have been estimated at several million dollars annually by several authors (McCausland & Millar 1982; Lorenzen *et al.* 1993; Van Donkersgoed *et al.* 2001; McKenna *et al.* 2002). Bruises are defined as tissue damage with rupture of the vascular supply and accumulation of blood and serum (Hoffman *et al.* 1998). These can occur during most of the pre-slaughter stages, including loading at the farm level, transportation and unloading with or without a lairage period at the abattoirs (Kenny & Tarrant 1987; Warriss *et al.* 1990; Jarvis *et al.* 1995). In Uruguay, it is unlikely that they occur earlier because the animals are raised in a pasture (Strappini *et al.* 2009; Huertas *et al.* 2010).

Bruises in cattle have a significant association with improperly maintained trucks for transporting animals, long distances shipments, bad state of roads,

inappropriate handling of the cattle at the pre-slaughter stages and presence of horned animals (Warriss *et al.* 1995; Huertas *et al.* 2010; Strappini *et al.* 2010). Therefore, carcass damages result, not only in an economic loss to the meat chain but also it is a strong indicator of poor animal welfare. (Grandin 1997, 2000). Cattle coming from auction markets are loaded and unloaded several times, increasing the probability of injury (McNally & Warriss 1996; Grandin 2000; Costa 2006).

Bruises in bovine carcasses affect the quality of the meat and bruised carcasses are downgraded, reducing the economic value of the whole carcass (Gallo *et al.* 1999). Immediate consequences are 'dark cuts', condemned zones and low quality meat (Kelly *et al.* 1998; Knowles & Warriss 1999). Extent, depth and localization of bruises are important factors, thus the amount of meat trimmed from carcasses varies according to different authors between 0.5 and 6.0 kg per carcass (Marshall 1976; McNally & Warriss 1996). Moreover, from the economic point

of view, bruises located at the hindquarter affect the most expensive meat cuts and extra costs due to trimming also add to the losses caused by bruises (Costa 2006).

The objective of this work was to evaluate the most frequent bruises in bovine carcasses observed during slaughter in Uruguay and to estimate the economic losses due to partial condemnation of the carcass and extrapolate the severity of the impact on the welfare of cattle.

Materials and methods

An assessment of carcass bruises in 13 Uruguayan abattoirs licensed by the Livestock, Agriculture and Fisheries Ministry and authorized to export to the European Union (EU) and the North American countries, was performed during the 2-year period (2002–2003). The visited abattoirs were representative for the country of Uruguay because 85% of the total beef cattle were slaughtered here. The slaughtered cattle were mostly Hereford steers weighing a mean of 450 kg. The abattoirs were located as follows: 46% in the south zone of the country; 15% in the Middle West zone and 39% of the plants located in the North zone. Each abattoir slaughtered an average of six hundred animals per day and they were visited at least twice during the study period, including different weather seasons.

Scoring of bruises

Bruises and carcass identification were recorded by three of the authors and four veterinary students who were trained as observers. Concordance levels between observers were found acceptable for a subjective method (80%, Kappa = 0.5) (Huertas *et al.* 2010). Each pair of observers assessed all carcasses slaughtered the day of the previous visit at the abattoir using an adapted subjective scoring methodology (Strappini *et al.* 2009). Although all bruises are important from the animal welfare point of view; we only recorded the fresh ones and those with a bright red colour. Older bruises, most probably, originated at the farm and were very few and not the subject of the present study.

Localization of the bruises

The visual appraisal of bruising was confined to four areas (butt, loin, rib and shoulder) performing the identification, classification and quantification of bruises by zone and degree of muscle participation.

Classification of bruises according to depth or severity

Severity was classified into two grades according to the amount of tissue affected: superficial tissue (subcutaneous) = grade 1, and involving muscular tissue and sometimes bone = grade 2.

Separation of carcasses to weigh the bruises

One hundred carcasses with all type of bruises were separated for convenience off the line and the meat trimmed for each bruise was saved in a plastic bag. Later that same day, the bag was weighed and each bruise was recorded separately using a digital scale (Rimont model MT 8461 RIMONT Sistemas - Grupo Access, <http://www.rimont.com>, Argentina) with a capacity to weigh up to 15 kg with a precision of 0.005 kg. In addition, zone and depth of each individual bruise was also recorded.

Data analysis

Descriptive analysis was performed with a statistical package Intercooled Stata 11.2 (StataCorp LP, USA, 2009) in order to obtain the frequencies of each variable considered. The association between the categorical variables (zone in the carcass and degree of deepness) were tested by the chi square test.

To evaluate the economic losses, the following formula was developed:

$$\bar{x} = \frac{\sum_{i=1}^z \sum_{j=1}^{Gr} (p_{ij} \times \text{weight}_{ij})}{N}$$

where \bar{x} is the estimated average loss by carcass; z is the number of zones considered, in this case 4; i is the index of areas ranging from 1 to z ($z = 4$); Gr is the degree of bruise depth in two categories: superficial and deep; j is the index of grades varying

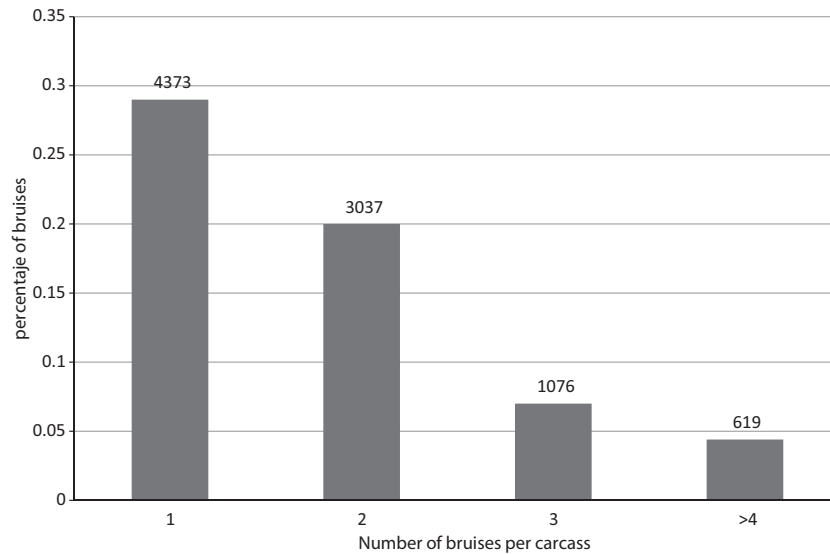


Fig. 1. Distribution of bruises per carcass.

from 1 to 2; p_{ij} is the frequency of bruises in zone i , grade j ; weight is the weight of bruises in zone i , grade j ; Σ is the sum; and N is the number of carcasses observed.

Potential changes in the destination of the meat cuts or downgrading of the carcasses as well as the higher costs at the industry to trim the damaged carcasses were not considered in this study.

Results

Amount of bruises found in carcasses

The total number of carcasses observed during the study was 15 157, of which 60.0% (9105) presented at least one bruise. In damaged carcasses, the number of bruises varied from 1 to more than 4 as shown in Fig. 1.

From the total damaged carcasses (9105), 58.0% (5246) had bruises only on one side while, while 42.0% (3859) had bruises on both sides.

As shown in Table 1, the prevalence of bruises grade 1 was 71.0% and bruises grade 2 was 29.0%. According to the localization of bruises, the butt zone had the greatest number of bruises compared with other zones of the carcass, with 58.25% of grade

1 and 21.78% grade 2. An association between zone and depth was found in carcass bruises [$\chi^2_{(3)} = 51.63$ $P < 0.001$] meaning that the butt zone had the most bruises and also the deepest ones.

Quantification of losses

The mean weight and standard error of the trimmed parts ($n = 100$) was 1602 ± 212 g with a minimum of 50 and a maximum of 4900 g.

Table 2 presents the mean weight of trimmed bruises in grams by localization and depth.

The estimation of direct losses was calculated as the product of the number of bruises by the estimated weight of condemnation, divided by the total number of slaughter cattle observed, reaching a loss of 899 g per animal slaughtered in Uruguay (Table 3).

Discussion and conclusions

The percentage of bruised carcasses observed in Uruguayan slaughter plants was high (60.0%). This result agrees with those found in other countries by Van Donkersgoed *et al.* (2001), McKenna *et al.* (2002), among others. However, Gallo *et al.* (2000)

Table 1. Prevalence of bruises according to depth and localization in the damaged carcass

	Prevalence of bruises by localization				Total
	Butt	Rib	Loin	Shoulder	
Grade 1	58.25% (5304)	5.60% (510)	3.91% (356)	3.24% (295)	71.0% (6465)
Grade 2	21.78% (1983)	2.90% (264)	1.54% (140)	2.78% (253)	29.0% (2640)
Total	80.03% (7287)	8.5% (774)	5.45% (496)	6.02% (548)	100% (9105)

Table 2. Mean weight in grams of bruises by localization and severity

	Amount of meat lost by bruising (g)			
	Butt	Rib	Loin	Shoulder
Grade 1	780	625	800	625
Grade 2	1100	2100	1700	1700

and Strappini *et al.* (2010) observed a relatively low prevalence of bruises (varying from 8.0% to 20.0%) in slaughterhouses in Chile. These variations in the results between authors and regions may be due to different production systems and/or different methodologies for the diagnosis and recording of bruises. So far, there are no indications reported for a better welfare situation during transport in Chile. Differences do exist between feedlot and grazing systems, since cattle in feedlots are more in contact with humans. Furthermore, an association between distance to slaughterhouses and the number of bruises is reported (Huertas *et al.* 2010). The method to register the bruises can vary with the observer, the training, experience and particular conditions in each slaughter plant such as the speed of the slaughterline, the place where the observer is located and lighting.

It is worth mentioning that in our study, trained observers recorded the bruises so that most of the above-mentioned factors were minimized. This was confirmed by the concordance levels between observers (80%, Kappa = 0.5) (Huertas *et al.* 2010).

The high percentage of bruises, observed in the present study, could be explained in part by the conditions for animals during transport, including bad maintenance of vehicles, the presence of 'guillotine-type' door at the rear end in most of the trucks, the state of the roads and the frequent use of devices to force animals to move, such as: electric prod (75%), sticks (3%), loud shouts (40%) and a combination of all of them as we found in previous studies (Huertas *et al.* 2010).

It is well demonstrated that animals sold through the auction markets have the highest risk of showing bruises compared to those delivered by dealers (Weeks *et al.* 2002), however, in the present study, all the animals came directly from the farms to the slaughterhouse by trucks. Clearly, transportation, loading and unloading are very important criteria pertaining to animal welfare in the pre-slaughter stages (Wythes *et al.* 1985).

Considering the number of bruises recorded per animal, it is remarkable that more than 4000 carcasses had one bruise, indicating that these animals

Table 3. Calculated average loss of meat by bruises according to grade, zone per slaughtered animal

	Calculated weight (g) per slaughtered animal				Total (g)
	Butt	Rib	Loin	Shoulder	
Grade 1	432.58	42.43	61.75	57.03	
Grade 2	169.10	41.56	32.30	62.14	
Total	601.68	84.00	94.06	119.16	898.90

had at least one injury. Moreover, several animals had two, three or more than four bruises.

With respect to localization and depth of bruises, the butt zone was the most damaged (80.03%) with the majority of bruises also in depth (21.78%), followed by the rib zone (8.5%), the shoulder (6.02%) and the loin (5.45%), respectively.

The high percentage of bruises in the butt zone could be due to the truck doors that can fall on the back of the cattle when they are passing, perhaps because of the lack of trained personnel. Furthermore, it is the region with the most valuable meat cuts from the economic point of view. Carcass bruises are probably caused by the method of handling the animals, poorly maintained trucks and failures at the trailer gate openings rather than butting or mounting. This behaviour is more because the animals are not familiar when they are let in the lairage pens (Huertas *et al.* 2010; Strappini *et al.* 2012).

Rib zone involves a very popular cut called *asado* by Uruguayan people and almost 22.0% of deep bruises in this region imply a great disservice to the local consumers and stakeholders.

It is common practice in some countries to pay producers only after the trimmed meat is removed; this implies a decrease in the money that the farmers receive when selling their animals. If the estimated prevalence of carcass bruises was 60.0%, the Uruguayan meat chain would lose at least 899 grams of high quality meat per animal slaughtered. In Uruguay, the mean number of cattle slaughtered per year is about 2.5 million heads, thus almost 2 million tons of high quality meat is wasted each year. In 2012, the average meat price 'on hook' in the country, was approximately US\$4 per kg implying a loss of approximately 8 billion American Dollars (US\$) per year in the country due to bruises, not taking into consideration that the most valuable parts of the carcasses was damaged.

Even though in some countries quality audits have been performed, very few studies considered this economic point of view, taking into account losses in terms of beef export and income to producers. However, apart from the economic losses, the welfare of

the animals involved is also seriously impaired. Bruises are painful and may be caused by conditions during transport and handling of the animals. These are already stressful events because they are living the entire year outside on pasture and are not used to the proximity of humans or being transported in a truck. Adding pain to this stress will have a detrimental effect on the welfare of these animals during the last hours of their life. As a consequence, bruising is associated with stress and subsequent appearance of dark, firm and dry (DFD) meat which is also downgraded and an economic loss (McNally & Warris 1996; Strappini *et al.* 2010). Particularly in developing countries, sometimes, the economic perspective of welfare has a greater impact than ethical or moral aspects of animal welfare (Appleby & Huertas 2011) and could be a strong drive (incentive) for improvement.

Results from the present study show that the amount of bruises that appear on the carcass clearly indicates a failure in the management of livestock. Animal welfare is seriously compromised but the bruises also cause important economic losses to the entire meat sector, including farmers who are most affected. Further studies at all levels (farms, transport and industry) are needed. As previously shown (Huertas *et al.* 2010), most bruises are related to handling and transport to the slaughterhouse. Maybe that the economic factors may stimulate the people involved to alter their behaviour and routine in order to minimize the unnecessary losses and to improve the conditions for the animals.

Acknowledgements

This study was performed in the Facultad de Veterinaria-Universidad de la República-Uruguay as a Research Project 'Identification of Critical Points affecting the welfare of pre-slaughter cattle and its consequences on carcass and meat quality' funded by the Instituto Nacional de Investigaciones Agropecuarias (INIA) of Uruguay. The authors thank the Uruguayan Meat Industry for allowing us to make the observations and records.

Conflict of interest

The authors wish to confirm that there are no known conflicts of interest associated with this publication and there has been no significant financial support for this work that could have influenced its outcome.

Contribution

Trying to characterize bruises in bovine carcasses and estimating the economic losses, an improving on the animal welfare and a decreasing in carcass damage will be the contribution of this paper.

References

- Appleby M.C. & Huertas S.M. (2011) International issues. In: *Animal Welfare*, 2nd edn (eds M.C. Appleby, J.A. Mench, I.A.S. Olsson & B.O. Hughes), pp. 304–314. CABI.
- Nanni Costa L., Lo Fiego D.P., Tassone F. & Russo V. (2006) The relationship between carcass bruising in bulls and behaviour observed during pre-slaughter phases. *Veterinary Research Communications* **30**, 379–381.
- Gallo C., Caro M. & Villarroel C. (1999) Characteristics of cattle slaughtered within the Xth Region (Chile) according to the terms stated by the official Chilean standards for classification and carcass grading. *Archivos de medicina veterinaria* **31**, 81–88.
- Gallo C., Perez S., Sanhueza C. & Gasic J. (2000) Effects of transport time of steers before slaughter on behaviour, weight loss and some carcass characteristics. *Archivos de medicina veterinaria* **32**, 157–170.
- Grandin T. (1997) Assessment of stress during handling and transport. *Journal of Animal Science* **75**, 249–257.
- Grandin T. (2000) *Livestock Handling and Transport*, 2nd edn. CABI Publishing, New York, NY.
- Hoffman D.E., Spire M.E., Schwenke J.R. & Unruh J.A. (1998) Effect of source of cattle and distance transported to a commercial slaughter facility on carcass bruises in mature beef cows. *Journal of the American Veterinary Medical Association* **212**, 668–672.
- Huertas S.M., Gil A.D., Piaggio J.M. & van Eerdenburg F.J.C.M. (2010) Transportation of beef cattle to slaughterhouses and how this relates to animal welfare and carcass bruising in an extensive production system. *Animal Welfare* **19**, 281–285.
- Jarvis A.M., Selkirk L. & Cockram M.S. (1995) The influence of source, sex class and pre-slaughter handling on the bruising of cattle at two slaughterhouses. *Livestock Production Science* **43**, 215–224.
- Kelly K., Kreikemeier J. & Unruh T.E. (1998) Factors affecting the occurrence of dark-cutting beef and selected carcass traits in finished beef cattle. *Journal of Animal Science* **76**, 388–395.
- Kenny F.J. & Tarrant P.V. (1987) The behaviour of young Friesian bulls during social re-grouping at an abattoir. Influence of an overhead electrified wire grid. *Applied Animal Behaviour Science* **18**, 233–246.
- Knowles T. & Warriss P. (1999) Effects on cattle of transportation by road for up to 31 hours. *The Veterinary Record* **145**, 575–582.
- Lorenzen C.L., Hale D.S., Griffin D.B., Savell J.W., Belk K.E., Frederick T.L. et al. (1993) National Beef Quality Audit: survey of producer-related defects and carcass quality attributes. *Journal of Animal Science* **71**, 1495–1502.
- Marshall B.L. (1976) Bruising in cattle presented for slaughter. *New Zealand Veterinary Journal* **25**, 83–86.
- McCausland I.P. & Millar W.C. (1982) Time of occurrence of bruises in slaughter cattle. *Australian Veterinary Journal* **58**, 253–254.
- McKenna D., Roeber D., Bates T., Schmidt T.B., Hale D.S., Griffin D.B. et al. (2002) National Beef Quality Audit-2000: survey of targeted cattle and carcass characteristics related to quality, quantity and value of fed steers and heifers. *Journal of Animal Science* **80**, 1212–1222.
- McNally P.W. & Warriss P.D. (1996) Recent bruising in cattle at abattoirs. *The Veterinary Record* **138**, 126–128.
- Strappini A.C., Metz J.H.M., Gallo C.B. & Kemp B. (2009) Origin and assessment of bruises in beef cattle at slaughter. *Animal* **3**, 728–736.
- Strappini A.C., Frankena K., Metz J.H.M., Gallo B. & Kemp B. (2010) Prevalence and risk factors for bruises in Chilean bovine carcasses. *Meat Science* **86**, 859–864.
- Strappini A.C., Frankena K., Metz J.H.M. & Kemp B. (2012) Intra- and inter-observer reliability of a protocol for post mortem evaluation of bruises in Chilean beef carcasses. *Livestock Science* **145**, 271–274.
- Van Donkersgoed J., Jewison G., Bygrove J., Gillis K., Malchow D. & McLeod G. (2001) Canadian Beef Quality Audit 1998-99. *The Canadian Veterinary Journal* **42**, 121–126.
- Warriss P., Bevis E. & Young C. (1990) Transport and lairage times of lambs slaughtered commercially in the south of England. *The Veterinary Record* **127**, 5–8.
- Warriss P., Brown S. & Knowles T. (1995) Effects on cattle of transport by road for up to 15 hours. *The Veterinary Record* **136**, 319–323.

Weeks C.A., McNally P.W. & Warriss P.D. (2002) Influence of the design of facilities at auction markets and animal handling procedures on bruising in cattle. *The Veterinary Record* **150**, 743–748.

Wythes J.R., Kaus R.K. & Newman G.A. (1985) Bruising in beef cattle slaughtered at an abattoir in southern Queensland. *Australian Journal of Experimental Agriculture* **25**, 727–733.