

Quantity, Location, and Description of Bruises in Beef Cattle Slaughtered under Sanitary Inspection

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ABSTRACT

Background: The distance traveled by trucks carrying cattle from farm to slaughterhouse can affect the resultant quality of beef due to the occurrence of injuries en route. The types of injuries that can occur vary according to the depth, size, location, and quantity of the injuries. Staining can be used to determine the age of the lesions and estimate the time when the injury occurred, thereby providing information that can be used to make changes in the trucking of cattle in order to decrease or eliminate the injuries. The effects associated with three transportation distances when hauling 20 cows per livestock truck were investigated. The collected data focused on the age, depth, size, quantity, and location of bruises found on beef carcasses slaughtered in the mesoregion of Triângulo Mineiro and Alto Paranaíba, Brazil, in January of 2012.

Materials, Methods & Results: A total of 320 cows were randomly divided into three groups according to the distance traveled via livestock truck from the farm to the slaughterhouse. Each truck carried 20 cows. In groups A (n = 140), B (n = 40), and C (n = 140), the cattle traveled 50 to 60 km, 90 to 110 km, and 140 to 166 km, respectively. Any extant contusions were visually observed on the production line after skinning, and relevant data were recorded using the respective animal's identification tag as the identifier and analyzed. Of the 320 animals analyzed, 285 (89.06%) had one or more lesions (i.e., a total of 682 bruises in the entire sample), which is consistent with the results of similar studies found in the literature. Distances did not statistically influence the amount of bruising. For all distance conditions, the anatomical site on the cow with the highest incidence of injuries was the hindquarter (71.41%), and the lowest incidence was the loin (4.55%). No association between distance and location of bruises was observed. For all groups, a majority (48.09%) of the bruises were small (i.e., 2-8 cm in diameter), whereas 36.66% and 15.25% were classified as medium (i.e., 9-16 cm in diameter) and large (i.e., more than 16 cm in diameter), respectively. An association between the site of injury and depth was observed. Most contusions (62.02%) were older (i.e., occurred more than 24 h before data collection), but 37.98% occurred less than 24 h before data collection.

Discussion: Previous studies that analyzed the number of bruises in cattle reported similar results to those found in the present study. The fact that distance and the amount of bruising do not correlate can be explained; i.e., injuries depend on many factors beyond distance traveled, such as the type of road traveled, number of stops, truck speed, time of travel, road conditions, and specific driver ability. The anatomical site with the highest incidence of injuries, i.e., the hindquarter, contains the larger muscle groups, thereby potentially predisposing it to a greater number of injuries. The small lesions (i.e., 2 to 8 cm in diameter) were the most prevalent independent of transport distance and affected only the subcutaneous tissue, thereby leading to less damage to the meat. Old bruises (i.e., occurred more than 24 h prior to identification) were most numerous in total and for each condition and were characterized by a yellowish color. Given their age, these injuries may have been caused by inadequate management on the farm, especially during the process of separating the cattle for transport, and not necessarily during the actual transport or at slaughterhouse.

Keywords: injury, transportation, distance, livestock handling, cattle.

INTRODUCTION

The beef cattle industry is a major component of the agribusiness sector and is gaining market share [8]. The Brazilian production of beef in 2011 was 7,447 thousand tonnes of carcass with a projected 7,954 thousand tonnes in 2012 [5]. Each year the beef industry loses millions of dollars due to the occurrence of injuries [9]; some of these injuries may be the result of inadequate management on farms, the condition of the body after animal transport, type of road traveled during transport (paved or not), travel distance from the farm to the slaughterhouse, improper handling at the slaughterhouse, or animal-specific factors (e.g., age and sex) [2,4,7,11]. Injuries can be characterized by their size and coloration, the latter of which allows for the general identification of the stage in the production process in which the bruises likely occurred [10,15]. Maintenance of animal health during transport is necessary in order to ensure greater consistency in terms of meat quality. Furthermore, prevention of injuries is important because they are indicative of violence and pain inflicted on the animal [17].

The aim of the present study was to investigate the effect of three transport distances for cattle that were moved from the farm to the slaughterhouse. More specifically, the number, age, depth, size, and location of bruises on the beef carcasses were assessed. The study focused on cattle transport in the mesoregion of Triângulo Mineiro and Alto Paranaíba, Brazil, due to a shortage of information in this region and its importance to meat production for Brazilian trade and export.

MATERIALS AND METHODS

Sampling

Sampling was carried out in a slaughterhouse located in the mesoregion of Triângulo Mineiro and Alto Paranaíba in January of 2012. In total, 320 adult cows raised in an intensive land use system in different municipalities and transported by livestock truck with a capacity for 20 head of cattle. The animals were randomly divided into three groups based on the distance that they traveled via livestock truck from the farm to the slaughterhouse. The following criteria were used to define the groups: 50 to 60 km traveled (Group A), 90 to 110 km traveled (Group B), 140 to 166 km traveled (Group C). Groups A and C included

seven trucks each (i.e., for a total of 140 animals in each group), and Group B included two trucks (i.e., for a total of 40 animals).

Process

After disembarking, the animals were subjected to an ante-mortem inspection. The animals were then rested, and food and water were withheld for an average of 19 h. Once slaughtered, they were suspended by their hind legs via an electric winch and processed with the aid of an aerial automatic rail. All of these procedures and the postmortem examination were in accordance with the Regulation of Industrial and Sanitary Inspection of Animal Products (RIISPOA) [6].

In the slaughtering process, the animals were stunned, bled, and skinned. After removal of the skin, the researchers proceeded to identify and record details associated with lesion sites on the carcasses; these examinations were made in inspection lines H and I focused on the inspection of the medial and lateral parts of the cranial and caudal half-carcasses. Data were recorded for bruises found in the following anatomical locations: ribs, loin, front quarter, and hindquarter.

Data Analysis

The lesions were classified according to their age (i.e., by color), size, and depth. In order to determine the age of the lesions (i.e., old versus new), the criteria proposed by Renner was adopted [15]. Recent injuries, i.e., those less than a day old, have a hemorrhagic dark red coloration, while older injuries, i.e., those more than a day or even weeks old, have a yellowish coloration. Therefore, coloring can be used to estimate in which management stage the injury likely occurred [16]. To determine the size of the bruises, the methodology proposed by Lagomarsino [14] was adopted, which classifies bruise diameters into the following categories: 2 to 8 cm as small, 9 to 16 cm as medium, and greater than 16 cm as large. After training, the researchers used a centimeter ruler to visually determine the size of the lesions. Lesion depth was classified as “S” when it reached the subcutaneous tissue, “M” when it included the subcutaneous tissue and muscle, and “O” when it included the subcutaneous tissue, muscle, and bone. After identification and verification of the lesion depth, all observed lesions were grouped according to region (i.e., rib, front quarter, loin, and hindquarter) to determine where on the carcass the lesions were found most frequently.

Statistical Analysis

Double-entry contingency tables were created for the study variables (i.e., distance traveled via truck and location, size, age, depth, and number of bruises on the carcasses) to test the dependency relationships between them, two by two. For this purpose, a non-parametric test of independence was used with a significance level of 5% ($P < 0.05$). SPSS® statistical software (SPSS® Statistics) was used to complete the statistical analyses.

RESULTS

Of the 320 carcasses evaluated, 285 (89.06%) had one or more lesions. In total, the entire sample population had 682 injuries (Table 1). The most frequent anatomical site of injury was the hindquarter (71.41%), followed by the ribs (13.34%), the front quarter (10.70%), and the loin (4.55%); this was independent of the distance traveled (Table 2).

Small bruises (i.e., 2 to 8 cm) were more prevalent (48.09%) for all three distance groups (Table 3). Medium and large lesions were found with higher frequency (i.e., 17.89% and 9.24%, respectively) in the Group A, i.e., animals transported the shortest distance. Animals in Group B exhibited a lower prevalence of small lesions (i.e., 7.04%) despite the fact that animals in all three travel distance groups had the highest number of lesions classified as small

injuries. Based on statistical analysis, no significant correlation was observed between injuries and distance travelled; therefore, these factors are independent of each other. Consequently, the study hypothesis (i.e., a relationship exists between the type and frequency of injuries and distance travelled between the farm and slaughterhouse) is rejected.

The depth of injury is statistically associated with location ($P < 0.05$), but these variables are not independent. The most frequent injuries were of depth type S, i.e., subcutaneous tissue only (55.70%); moreover, the most frequent anatomical site for lesions was on the hindquarter (i.e., 71.40% of all lesions) (Table 4). No carcasses were found to have bruises of depth type O, i.e., involving subcutaneous tissue, muscle, and bone. Both of the other types of bruises (i.e., types M and S) were found on the hind quarter, where the most valued commercial cuts are located.

Older lesions (i.e., those more than one day old) were the most prevalent (i.e., 423 lesions (62.02%) in all of the groups) (Table 5). Of these, 192 lesions (28.15%) were found in animal carcasses from Group A, and 175 (25.66%) lesions were found in carcasses from Group C. New lesions were also more prevalent in Group A group (i.e., 135 lesions or 19.79% of all the lesions in total). Nevertheless, as previously indicated, older lesions were the most prevalent for all of the groups overall.

Table 1. Prevalence of injuries in cattle transported across three distances and slaughtered in abattoirs in the mesoregion of the Triângulo Mineiro and Alto Paranaíba, MG, Brazil in 2012.

Distance/Group	Animals (N)	Without injury	Carcasses with bruises	Total of bruises	Carcasses with injury (%)
50 to 60 km	140	12	128	327	44.92%
90 to 110 km	40	5	35	74	12.28%
140 to 166 km	140	18	122	281	42.80%
TOTAL	320	35	285	682	89.06%

Table 2. Location of injuries in cattle transported across three distances and slaughtered in abattoirs in the mesoregion of the Triângulo Mineiro and Alto Parnaíba, MG, Brazil in 2012.

Site/ Group	50 to 60 km	90 to 100 km	140 to 166 km	Total/Site
Back	220 (32.26%)	54 (7.92%)	213 (31.23%)	487 (71.41%)
Loin	22 (3.23%)	2 (0.29%)	7 (1.03%)	31 (4.55%)
Rib	44 (6.45%)	12 (1.76%)	35 (5.13%)	91 (13.34%)
Front	41 (6.01%)	6 (0.88%)	26 (3.81%)	73 (10.70%)
Total Group	327 (47.95%)	74 (10.85%)	281 (41.20%)	682 (100%)

Table 3. Size of bruises on the carcasses of cattle transported across three distances and slaughtered in abattoirs in the mesoregion of the Triângulo Mineiro and Alto Parnaíba, MG, Brazil in 2012.

Size/ Group	50 to 60 km	90 to 110 km	140 to 166km	Total/Size
1 - small*	142 (19.82%)	48 (7.04%)	138 (20.23%)	328 (48.09%)
2 - medium**	122 (17.89%)	19 (2.78%)	109 (15.98%)	250 (36.66%)
3 - big***	63 (9.24)	7 (1.03%)	34 (4.98%)	104 (15.25%)
Total Group	327 (47.95%)	74(10.85%)	281 (41.20%)	682 (100%)

*2 to 8 cm of length; **9 to 16 cm of length; ***More than 16 cm of length.

Table 4. Depth of bruises in relation to their locations on the carcasses of cattle slaughtered in abattoirs in the mesoregion of the Triângulo Mineiro and Alto Parnaíba, MG, Brazil in 2012.

DP/Site	Rib	Front	Loin	Back	Total/DP
M*	20 (2.9%)	27 (4.00%)	12 (1.80%)	243 (35.60%)	302 (44.30%)
S**	71 (10.40%)	46 (6.70%)	19 (2.80%)	244 (35.80%)	380 (55.70%)
Total Site	91 (13.30%)	73 (10.70%)	31 (4.50%)	487 (71.40%)	682

M*: affects the subcutaneous tissues and muscle; S**: affects only the subcutaneous tissue.

Table 5. Age of bruising in cattle transported across three distances and slaughtered in abattoirs in the mesoregion of the Triângulo Mineiro and Alto Parnaíba, MG, Brazil in 2012.

Age/ Group	50 to 60 km	90 to 110 km	140 to 166 km	Total/Age
New	135 (19.79%)	18 (2.64%)	106 (15.54%)	259 (37.98%)
Old	192 (28.15%)	56 (8.21%)	175 (25.66%)	423 (62.02%)
Total Group	327	74	281	682

DISCUSSION

The percentage of injuries found in this study is similar to those reported in previous studies, in which 102 out of 121 carcasses of cattle (84.3%) slaughtered in the Pantanal had one or more lesions, i.e., with 279 injuries in total [3]. Also, another study in the same region reported 83 lesions (94.3%) found in 88 carcasses [2]. However, these results differ from that reported by other authors who found an incidence of lesions on carcasses of 12.3% in two slaughterhouses [18]. These injuries are of interest because they directly affect the quality of the meat due to physical damage to the muscle; moreover, these injuries are indicative of prior abuse inflicted on the animals, thus affecting animal welfare [8].

The most significant finding in this study is that distance traveled and the number of bruises on the carcass are not significantly related. Likely, the occurrence of injury depends on factors other than distance. Indeed, the driving behavior of the driver, truck speed, travel time, number of stops, and road conditions [19] may be more closely related to the number of bruises that appear on the carcass; moreover, braking and sudden deviations in course that are common in these conditions [2] can certainly affect the appearance and amount of bruising on the animal.

The observation that the hindquarter was the site with the highest occurrence of bruising was similar to the results from a previous research [2], in which the hindquarter portion of the carcass was more frequently injured in beef cattle in the Pantanal of Mato Grosso. The higher incidence of injuries in this anatomical region may be related to the fact that the larger muscle groups are located in this portion of the carcass, thereby predisposing it to a greater number of injuries.

The size of the bruise was associated with the distance traveled. Moreover, animals transported a short distance seemed to have a greater amount of bruising; however, this might be related to the road condition (e.g. paved or gravel and number of potholes), skill and ability of the truck driver, condition of the truck and the livestock holding area, etc. A future study has been planned for the investigation of these aspects due to their importance. Previous research has already indicated that animals transported on unpaved roads show a high incidence of injuries as a result of traversing bumps in the road, braking, and sudden deviations, all of which are most likely related to potholes [13]. Other factors specifically related to the animals, such as gender, age, and fat cover, can affect the development of bruising in cattle as well [12,19].

Both of the lighter types of bruising, (i.e., Types S and M, involving the subcutaneous tissue and both the subcutaneous tissue and the muscle, respectively) were most commonly located on the hindquarter, which is the region where the most valued commercial cuts are located. Similar results have been reported; i.e., after analyzing the prevalence of lesions in the carcasses of beef cattle slaughtered in the Pantanal of Mato Grosso, an earlier study found that the caudal portion of the carcass was the most injured [1,3]. This situation can be explained by the fact that this region of the animal's body contains a higher proportion of tissue in relation to the rest of the body, thereby favoring a higher incidence of injuries. Regarding the degree or depth of injury, severe bruising (grade 1) has most often been found in Chilean cattle [18].

The bruises classified as "old" were the most prevalent in total and for each group. These are defined as occurring at least 24 h prior to their identification [16]. These injuries likely occurred well before the cattle were transported and may have been caused by inadequate management on the farm, especially during the process of separating the cattle for transport.

CONCLUSION

Distance travelled is not the only factor that could affect the amount of bruising observed on cattle carcasses post mortem. Other factors, such as driver ability, road conditions, etc., can be involved. Cattle that traveled the shortest distance in this study (i.e., 50 to 60 km) had in the most lesions. The hindquarter is the location of the larger muscle groups, which may be the reason that a higher incidence of bruising and greater depth of bruising was observed in this zone. Small lesions (i.e., 2 to 8 cm) were the most prevalent in the study sample, and the size of the lesion is not related to the distance traveled. The bruises likely occurred on the farm property because most were older than 24 h, thereby suggesting a need for improvement in the handling of the cattle on the farm.

Acknowledgements. This work was supported by a grant from the Fundação de Amparo à Pesquisa de Minas Gerais (FAPEMIG2012-AGR010), Brazil.

Ethical approval. The present study was evaluated by the Comissão de Ética no Uso de Animais da Universidade Federal de Uberlândia (CEUA/UFU), Uberlândia, MG, Brazil, with the protocol 9/12 and final analysis N° 006/12.

Declaration of interest. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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