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Genetic group and horns presence in bruises and economic losses in cattle carcasses

Grupo genético e presença de chifres em contusões e perdas econômicas em carcaças bovinas

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Abstract

Assessment of carcass bruises in steers and cull females, classified during unloading at the slaughterhouse according to genetic dominance in zebu and taurine cattle, and the presence of horns, including polled, horned and mixed batches. We considered horned the batches that included more than 20% of horned animals and mixed the batches that included less than 20% horned animals. The data were collected in a commercial slaughterhouse and included 93 batches, with a total of 2,520 animals, from different regions in Rio Grande do Sul. After evisceration, the bruises were identified and recorded in the different carcass regions: hip, round, ribs, forequarter and loin area per animal and batch. The weights of the removed tissue due to bruising was based on the average weights of various samples of bruises according to their degree of severity. Regarding the number of bruises per animal, no differences ($P > 0.05$) were observed between genetic groups, however, when comparing the total bruises per batch, differences were observed in all carcass regions, except for the forequarter, with a greater number of injuries in zebu than in taurine carcasses. The individual assessments showed 86.2% ($P < .05$) more bruises in the ribs region in horned than in polled animals carcasses. Horned batches had higher bruises mean ($P < .05$) compared to the polled, with increases of 65.1; 131.7 e 132.8 % in total bruises in the carcass, ribs and forequarter, respectively. The mixed batches did not differ from polled and horned batches. Zebu animals were responsible for higher industry loss totaling 1.21 kg, resulting in a economic loss of R $ 15.48 per carcass. The presence of horns resulted in greater carcass loss, 1.13 kg, with economic loss of R $ 16.11 per carcass. The bruises on carcasses are affected by the breed group and presence of horns, with zebu and horned groups leading to greater economic losses for the meat production chain.
Key words: Animal welfare. Carcass cuts. Taurine. Zebu.

Resumo

Foi realizado um estudo para avaliar as contusões na carcaça de machos castrados e fêmeas de descarte, classificados ao desembarque no frigorífico segundo a predominância genética em taurinos e zebuínos, e a presença de chifres, incluindo mochos, aspados e mistos. Foram considerados aspados os lotes que incluíam mais de 20% de animais aspados, e mistos menos de 20% de animais aspados. Os dados foram

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coletados em uma empresa frigorífica do RS, por intermédio da análise de 93 lotes, totalizando 2.520 animais, provenientes de diferentes regiões do estado. Após a evisceração, na linha de abate, foram identificadas as contusões e contabilizadas de acordo com as regiões da carcaça: quadril, traseiro, costela, dianteiro e lombo, por animal e total do lote. Os pesos dos tecidos removidos devido às contusões foi baseado nos pesos médios de várias amostragens das contusões de acordo com o grau de severidade das mesmas. Não houve diferenças (P > 0,05) no número de contusões por animal entre os grupos genéticos, porém, quando comparados os totais por lote, observou-se diferenças em todas as regiões da carcaça, com exceção do dianteiro, com maior número de contusões nos zebuínos em relação aos taurinos. Nas avaliações individuais houve aumentos de 86,2% (P < 0,05) de contusões para a região da costela dos animais aspados em comparação aos mochos. Lotes aspados apresentaram maior média (P < 0,05) de contusões em comparação aos mochos com aumento de 65,1; 131,7 e 132,8 % nas contusões totais na carcaça, na costela e no dianteiro, respectivamente. Os lotes mistos não diferiram dos mochos e aspados. A maior perda econômica ocorreu no grupo dos zebuínos, totalizando 1,21 kg/carcaça resultando em R$ 15,48 por carcaça. A presença de chifres resultou em maior perda em kg de carcaça (1,13 kg) com perda econômica de R$ 16,11 por carcaça. O grupo genético e a presença de chifres influenciam na ocorrência de contusões na carcaça, com susceptibilidade dos grupos zebuínos e aspados ocasionando maiores perdas econômicas para os produtores e às indústrias.

Palavras-chave: Bem-estar animal. Cortes da carcaça.

Introduction

The need for more sustainable animal production to meet the expectations of better-educated consumers with higher demand requires improved practices for the well-being and health of the animals. One of the factors influencing animal well-being is the pre-slaughter handling process. If this is not performed in the correct manner, bruising may occur in different regions of the bovine carcass (ANDRADE et al., 2009).

Petroni et al. (2013) confirmed that 98% of animals evaluated (n = 898) in their study showed some form of carcass bruising, with 15.6 kg of bruised tissue taken solely from the topside region of 133 animal carcasses, which was the area that presented greatest bruising (average 61.8%). In a study by Santos and Moreira (2011) conducted in Triangulo Mineiro (a region in the state of Minas Gerais), the authors showed that economic losses as a result of carcass bruising can affect up to 0.5% of the carcass price. Although there is a strong predilection for determining biological types through adaptation to certain cultural conditions, it should be borne in mind that no single genetic group has all the characteristics that constitute an ideal breed (DELGADO; SANTOS, 2010). There are clear behavioral differences in animals, based on their response to different conditions imposed during the batching and pre-slaughter processes at the slaughterhouse, and thus changes need to be made with regard to the handling and selection of animals.

The genotype of an animal has an influence on its behavior, particularly regarding fear. Animals of Indian origin, as well as related crossbreeds, are considered more sensitive and resistant to coexisting alongside humans (GRANDIN, 1997; SILVEIRA et al., 2006; SANT'ANNA et al., 2012). Resistance and fear during handling makes it difficult to lead animals during the pre-slaughter procedure, both on the farm and at the slaughterhouse, which results in a greater amount of bruising.

The presence of horned animals within a cattle batch can influence the amount and degree of bruising, as these animals tend to be dominant over hornless cattle (COSTA-E-SILVA, 2007), the former displaying their dominance by utilizing their horns to push and injure other cattle.

The present study aimed to evaluate the influence of genetic group and the presence of horns in cattle on the occurrence of bruising in carcasses, as well as their effects on economic losses.

Material and Methods

The present study was approved by the Ethics Committee for Animal Experimentation (CEEA – Comissão de Ética para Experimentação Animal) of the Federal University of Pelotas under the process number 23110.008794/2013-31 and acceptance code CEEA 8794.

The data were collected in a slaughterhouse located in the central region of the state of Rio Grande do Sul, between the months of August and November of 2013. Ninety-three cattle batches were evaluated, totaling 2,520 animals. Of these, 43 batches comprised castrated males and 50 batches comprised cull females. The average number of animals per batch was 30 in the males (ranging from 12 to 100 animals) and 25 in the female batches (ranging from 16 to 90 animals). The animals, which originated from different regions of the state, i.e., a total of 60 counties, were acquired through standard industry purchasing. Once purchased, the animals were transported using different types of vehicles, over distances ranging from 30 to 550 km, and traversing diverse topographical terrains and roads, which represent the typical transportation systems of the state. Batches featuring homogeneity in the studied variables were the only ones evaluated, in order that all treatments had similar distances and vehicles used for transportation to avoid confusion in the analysis of variables related to the occurrence of bruising.

After arrival and placement in the slaughterhouse's corrals, the animals remained fasting for a minimum period of 12 hours (BRASIL, 2013). The pre-slaughter animal handling followed the facility's standard daily routine, and was carried out by complying with the regulations of the Federal Inspection Service (Serviço de Inspeção Federal 1733). Upon arrival, batches were classified based on their genetic group: Taurine cattle (n = 57) predominance of animals of the batches with European phenotypic characteristics, compact muscle mass, strong bone structure, thick hide, small dewlap, long hair, a strong head with medium length chamfer, medium-sized ears, long and arched ribs, and either the presence or the absence of horns; zebu cattle (n = 36) predominance of animals of the batches with zebu phenotypic characteristics, hump, short and fine hair, dark skin, a head shaped like a coffin, medium to long ears, straight chamfer, black and dilated nose, either the presence or the absence of horns, and a large dewlap starting below the jaw and ending at the navel. Batches were also classified according to the presence or absence of animals with horns on: polled (n = 27), when there was not presence of animals with horns, mixed (n = 28) when the presence of horned animals was less than 20% of the total batch and, horned (n = 38), when the presence of horned animals was greater than 20% of total batch.

Individual identification of the carcasses inside the batches took place after slaughter and flaying of the animals. The bruises were quantified based on the region of occurrence on the carcass (hip, round, ribs, forequarter, and loin), and classified into three different degrees, according to their severity and area of coverage on the various carcass tissues, including surface fat, muscles, and bones. For bruises affecting only the subcutaneous fat or muscle surface, a Degree I classification was given; for bruises affecting deeper muscle tissue in addition to the subcutaneous tissue, a Degree II classification was given; and for bruises affecting the entire muscle mass reaching the bone tissue, with or without fracture, a Degree III classification was given (CHILE, 2002).

For the calculation of economic losses caused by bruising, tissues taken from the carcasses were weighed in accordance with the current legislation and under supervision from the Federal Inspection Service. In order to determine the total carcass losses, a weighted average was determined from the number of bruises associated with each classification degree, multiplied by the average weight of the evaluated bruises. The economic losses were multiplied by the selling price of the meat from the meat packing plant to retail sale. The prices used per kilogram of carcass for the different components were R$14.40 for the hip cut, R$12.10 for the round, R$10.20 for the ribs, R$7.75 for the forequarter, and R$15.40 for the loin (PASCOAL et al., 2009, 2011), with a final average price of R$10.94 kg^{-1}. This value, representing the sale price paid to the producer, corresponds to 2.27 kg of body weight of the average male and female cattle.

The experimental design for the present study included six treatments using a 2 × 3 factorial arrangement, i.e., two genetic groups and three classifications based on the incidence of horned animals. The data were statistically analyzed using an analysis of variance using SAS statistical software (2001). A *t* test was used to compare averages with up to 5% significance.

The analysis of variance model used was as follows:

$$Y_{ijklm} = \mu + BREED_i + HORN_j + (BREED \times HORN)_{ij} + N_k + S_l\, e_{ijklm}$$

Where Y_{ijklm} = dependent variables derived from observations made in the m-nth carcass, belonging to the i-nth genetic group and the j-nth presence or absence of horns;

μ = overall average from all observations;

$BREED_i$ = effect from the i-nth genetic group;

$HORN_j$ = effect from the j-nth presence or absence of horns;

$(BREED \times HORN)_{ij}$ = interaction between the i-nth genetic group and the j-nth presence or absence of horns;

N_k = effect of the number of animal covariables on the batch;

S_l = effect of the sex covariable on the batch; and

e_{ijklm} = the residual effect associated with the observation made on the m-nth carcass, NID (0, σ^2).

Results

The interaction between the genetic group and presence of horns was not significant ($P > 0.05$); consequently, the results for each factor are discussed separately. Evaluation of the total number of bruises observed on the carcasses revealed that individually evaluated zebu animals did not differ statistically ($P > 0.05$) from taurines, with averages of 2.31 and 1.74 bruises per animal, respectively (Table 1). A significant effect was observed for the covariates, number of animals in the batch and sex of animals, with the means corrected for these effects.

In the evaluation of total bruises per batch, significant differences ($P < 0.05$) were observed for all carcass cuts, with the exception of the forequarter. Zebu cattle showed a greater number of bruises than the taurine cattle, with 78.8%, 92.54%, 91.12%, 78.11%, and 64.5% more bruises for the hip, round, ribs, forequarter and loin cuts, respectively, and a 79.7% higher total occurrences of bruises in the carcasses ($P < 0.05$) when quantified per batch.

When evaluating the occurrence of bruises per animal and per batch, based on the presence of horned animals in the batches, there were no significant differences ($P > 0.05$) regarding the total number of bruises, with the exception of the ribs region, where the occurrence of bruises in the horned batches was higher in 86.2 and 137.2%, respectively, compared to the polled animals, not differing from the mixed batches (Table 2).

The forequarter cut when analyzed by the total bruises of the batch showed behavior similar to the ribs, with higher bruises (137, 4%) in the batches of animals with horns in relation to polled batches, not differing from the mixed batches. There were no effects ($P > 0.05$) of the occurrences of horned animals in the batches on bruises on the hip, round and loin cuts, expressed in number of bruises per animal or total per batch.

Table 1. Means, standard errors and indicatives of significance of bruises according with carcass regions and total, evaluated individually or by batch according with genetic group.

Carcass regions	N° of bruises/animal			N° of bruises/batch		
	Taurine	Zebu	P>t	Taurine	Zebu	P>t
Rip	0.46±0.09	0.64±0.05	0.1373	9.34±2.28	16.70±1.30	0.0128
Round	0.32±0.09	0.42±0.05	0.2003	5.90±2.38	11.36±1.30	0.0319
Rib	0.33±0.08	0.47±0.04	0.8497	6.76±1.90	12.92±1.09	0.3463
Forequarter	0.31±0.09	0.39±0.05	0.9973	5.53±1.95	9.85±1.11	0.5000
Loin	0.30±0.05	0.41±0.03	0.0786	6.82±1.29	11.23±0.74	0.0113
Total	1.74±0.34	2.31±0.19	0.2817	34.36±8.13	61.76±4.64	0.0375

Table 2. Means, standard errors and indicatives of significance of bruises according with carcass regions and total, evaluated individually or by batch according to the frequency of animal with horns in batches.

Carcass regions	N° of bruises/animal				N° of bruises/batch			
	Polled	Mixed	Horned	P>t	Polled	Mixed	Horned	P>t
Rip	$0.52±0.10^{a}$	$0.51±0.11^{a}$	$0.67±0.07^{a}$	0.3201	$11.5±2.6^{a}$	$14.4±2.7^{a}$	$16.6±1.7^{a}$	0.3268
Round	$0.39±0.11^{a}$	$0.37±0.11^{a}$	$0.44±0.07^{a}$	0.4432	$7.7±2.6^{a}$	$10.4±2.8^{a}$	$11.2±1.7^{a}$	0.4233
Rib	$0.29±0.09^{b}$	$0.38±0.10^{ab}$	$0.54±0.06^{a}$	0.0357	$5.9±2.0^{b}$	$10.0±2.2^{ab}$	$14.0±1.3^{a}$	0.0231
Forequarter	$0.29±0.09^{a}$	$0.33±0.10^{a}$	$0.38±0.06^{a}$	0.5605	$4.5±2.0^{b}$	$8.4±2.2^{ab}$	$10.7±1.3^{a}$	0.0422
Loin	$0.34±0.06^{a}$	$0.38±0.06^{a}$	$0.40±0.04^{a}$	0.5243	$8.1 ±1.4^{a}$	$10.4±1.5^{a}$	$10.9±0.9^{a}$	0.3157
Total	$1.84±0.38^{a}$	$1.98±0.40^{a}$	$2.45±0.24^{a}$	0.2217	$37.7±9.1^{b}$	$53.6±9.6^{ab}$	$63.6±5.9^{a}$	0.0345

Means within lines not sharing a common suffix are significantly different (P<0,05) by *t* test.

The average losses observed for the different degrees of bruising were 180; 1,500 and 3,900 g for degrees I, II, and III, respectively, resulting in an average 887 g of muscle loss from the various carcass cuts (Table 3). As shown in Tables 1 and 2, losses occurred across all evaluated cuts in varying proportions. The numeric losses resulting from the bruises, when weighted against the amount of tissue affected and removed from the carcasses, were different ($P < 0.05$) across all carcass cuts with respect to breed characterization and the frequency of horns (Table 3). Zebu cattle had greater losses (1,121 g carcass^{-1}) than taurine cattle (397 g carcass^{-1}).

Regarding the presence of horns, all regions except the loin showed greater losses in kilograms of carcass in batches classified as mixed or horned than in the polled batches. The average weight loss in the horned and mixed batches was 1,131 g and 841 g or 102.69% and 24.48% higher, respectively, than for the polled animals (558 g) batches.

Table 3. Means, standard errors and indicatives of significance of losses individually and totals (kg) caused per bruises to the different carcass regions according with genetic group and the occurrence of horned animals.

Carcass regions	% in the carcass[1]	Genetic group			Presence of horns			
		Taurine	Zebu	P>t	Polled	Mixed	Horned	P>t
		Losses, g			*Losses, g*			
Rip	10.12	104±7	303±4	0.0124	220±7 [b]	226±7[b]	281±5[a]	0.0345
Round	27.54	52±7	226±4	0.0134	89±8[b]	163±8[a]	230±5[a]	0.0356
Rib	10.82	62±7	233±4	0.0346	77±8[c]	110±8[b]	270±5[a]	0.0189
Forequarter	37.70	56±3	155±2	0.0348	44±4[b]	128±4[ab]	166±2[a]	0.0348
Loin	13.82	123±4	203±2	0.0401	157±4[a]	212±4[a]	182±2[a]	0.3266
Total	100.00	397±2	1121±1	0.0203	558±2[c]	841±2[b]	1131±1[a]	0.0283
		Losses. R$ carcass^{-1}			*Losses. R$ carcass^{-1}*			
Rip	10.12	1.12	4.40		2.57	3.06	3.99	
Round	27.54	0.62	2.73		1.21	2.16	2.73	
Rib	10.82	0.50	2.25		0.80	1.17	2.76	
Forequarter	37.70	0.29	1.18		0.41	0.81	1.34	
Loin	13.82	1.58	3.03		2.02	2.60	3.05	
Total	100.00	4.74	15.48		8.13	11.39	16.11	

[1] Adapted of Pascoal et al. (2009, 2011).
Means within lines not sharing a common suffix are significantly different (P<0,05) by *t* test.

Discussion

The average bruises per animal, although high in number, were close to the values indicated by Civieira et al. (2006), who confirmed an average of two to four bruises per carcass after evaluating male and female bovine carcasses slaughtered in a slaughterhouse in the same region where the present study was conducted. The authors suggested that the occurrence of bruises is linked to other factors, such as very rapid movement, wet floors, slippery and uneven surfaces, sharp projections in the facility, low or high batch density during transport, and long periods of dietary and chronic stress, which are further exacerbated by the presence of horns or by animal temperament influenced by breed (CIVIEIRA et al., 2006).

Hip and round bruises normally result from collisions with the corners of corrals and vehicle doors during handling, mainly during loading and/or unloading (HOFFMAN; LUHL, 2012), from groupings of animals not familiar with each other, and owing to this anatomical region having less fat deposition (ROMERO et al., 2013). In particular, the animal's temperament is the determining factor for the number of bruises on the carcass (SILVEIRA et al., 2006, 2008).

According to Silveira et al. (2008), this occurs partly because of the greater reactivity and more aggressive behavior of the animals in their attempts to flee. This higher reactivity and aggression become more significant when the animals have been raised under more extensive conditions with very little human contact (ROMERO et al., 2013).

Even in feedlots systems, where daily contact occurs between animals and handlers, Silveira et al. (2008) verified greater scores in reactivity (score = temperament, movement, and animal breathing) and flight distances for zebu cattle from the Nelore breed than for taurine cattle from the Charolais breed. While studying the carcasses of cattle from the Brahman, Bonsmara, and Beefmaster breeds, Mpakama et al. (2014) confirmed that breed was the determining factor in the occurrence and severity of bruising. Cattle from the Bonsmara breed showed a higher percentage (88%) of non-bruised carcasses, whereas those from the Beefmaster and Brahman breeds showed greater levels of severe bruising, at 4% and 3%, respectively.

The biological type of the animal, defined by the characteristics of the breed or breeds that prevail in the genetic composition, is essential to define the appropriate handling to be adopted in the guiding and transport of animals intended for slaughter. Hoffman and Luhl (2012) comment that the stress response to management depends on the differences between breeds, as well as differences within breeds. However, Fordyce et al. (1988) explain that the susceptibility to bruising and temperament differences between individuals is more intense than the difference between breeds.

The presence of horned animals in cattle batches increases the risk of bruising. Collins and Huey (2014) reported that the occurrence of bruising in slaughtered animals in the Australian industry is two times greater in horned animals than in polled cattle. In Uruguay, Huertas et al. (2010) observed a positive correlation between the occurrence of bruised carcasses and batches of horned animals, classifying at least one horned animal in the batch. The reactivity and rapid movements associated with the occurrence of horns in the animals should be taken into consideration in truck density recommendations (TARRANT et al., 1992). Animals transported at high densities, besides of not having sufficient space to take secure direction, increasing the risk of falls, they are also at greater contact potentiating the risks of injuries, especially when there is the presence of animals with horns in these situations (HOFFMAN; LUHL, 2012). Also in small loads, animals might use the available space to show dominance by using their horns (COSTA-E-SILVA, 2007).

Unlike bruises in other regions, loin bruises did not differ based on the genetic group or presence of horns. Normally, loin bruises are attributed to handling problems, due to the anatomical position of the cut in the body of the animal. The presence of horns should not have any influence on bruising because attacks among the animals do not affect the loin region. Loin bruising can occur in extreme cases where animals have fallen through trampling associated with the reactivity of the animals.

Loin bruises occur mainly from poking with sticks or cattle prods at the time of truck loading to force the movement of animals, from collisions with guillotine-like gates found in cage subdivisions on trucks, and from slaughterhouse corral management. Strappini et al. (2013) reported a bruising rate of 36.5%, correlating this with the impact of the gates hitting the loin of the animals. The literature emphasizes that handling during the guiding of animals is a problem, since gates do not work automatically (RUSSI et al., 2011), as are the logistics for transport vehicles because there is no protection that avoids or minimizes the severity of bruising (BERTOLONI et al., 2012).

Although differences were not found among the variables studied, the average numbers in the evaluation per animal and per batch were 0.56 and 14.11 for hip bruises, and 0.39 and 9.66 for round bruises, respectively, which represent losses for the bovine meat production chain. These losses negatively affect earnings and have an impact on where the best cuts of meat are obtained from the carcasses (VAZ et al., 2012). After evaluating 14,681 slaughtered carcasses in Uruguay, Huertas (2007) observed that 78% of bruises were located in the round cut region.

The results obtained in the present study are in accordance with those in the literature, since the hip is anatomically located in the pelvic region, at the rear of the animal. In their study involving 5,257 slaughtered animals in a commercial slaughterhouse in Namibia, Hoffman and Luhl (2012) confirmed, that 72% and 73% of round bruises located on the left and right side of the carcasses, respectively, occur at the hip. The authors attributed the causes of bruising in this region to facility problems, particularly with regard to protrusions at gate exits that compromise the normal flux of animals inside the corrals.

Economic losses caused by bruising determine devaluation and profitability for the producer and the industry, as the bruised materials are removed from the carcass after identification at several points along the slaughter line or during the deboning of the carcasses. Evaluating financial losses based on adjusted values according to market price makes it possible to evaluate losses per animal surpassing 226% for zebu cattle batches as against taurine batches (R$15.48 versus R$4.74). Financial losses per animal in the horned batches with more than 20% of horned animals (R$16.11) were twice those in the polled batches (R$8.13), with the mixed batches containing less than 20% of horned animals showing intermediate losses (R$11.39).

Conclusions

The occurrence of bruising in carcasses is influenced by the genetic group and by the presence of horned animals in batches. Zebu batches and those with horned animals had a greater occurrence of bruising and, consequently, incurred greater economic losses than did the taurine and polled batches.

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