Determination and evaluation of bruises in bovine carcasses in a slaughterhouse of the Nuble region, Chile

Determinación y evaluación de contusiones en canales bovinas en un matadero de la región de Ñuble, Chile

Reinaldo Letelier Contreras^{1*}, Paula Gädicke L'Huissier¹, Ignacio Barraza Tirado², Paulina Bruna Castillo³

Abstract

The aim of this study was to relate the degree bruises in bovine carcass with the characteristics of the animals and the transport distance to a slaughterhouse in the Nuble region, Chile, during the period November-December 2018. A total of 193 bovine carcasses were evaluated in which category, degree of bruises, sex, weight, and locality of origin were identified. Data showed that 76.2% (147/193) of the carcasses corresponded to males and 23.8% (46/193) to females. A total of 152 contusions were observed, being mainly grade 1 in 55.4% (107/193), followed by 21.8% (42/193) grade 2 and only 1.6% in grade 3 (3/193), while 21.2% (41/193) of the carcasses were free of contusions. Besides, 83.4% (161/193) of carcasses corresponded to category V. The largest number of animals (76.8%) came from distances of less than 60 km. There was no association between the distance of travel and the presence of bruises (p>0.05). However, although transport distance was not an influential factor in the appearance of bruises, sex (female) and greater weight separately were more prone to the appearance of bruises (p<0.05).

Keywords: bruises, bovine carcass, slaughterhouse, category

² Universidad de Concepción, Facultad de Ciencias Veterinarias/Escuela Concepción, Chillán, Chile

³ Universidad de Concepción, Facultad de Ciencias Veterinarias/Departamento de Ciencia Animal, Chillán, Chile

Received: February 21, 2024 Accepted for publication: February 7, 2025 Published: April 30, 2025

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¹ Universidad de Concepción, Facultad de Ciencias Veterinarias/Departamento de Patología y Medicina Preventiva, Chillán, Chile

^{*} Corresponding author: Reinaldo Letelier Contreras; reinaldletelier@udec.cl

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RESUMEN

El objetivo de este estudio fue relacionar el grado de contusiones en canales bovinos con las características de los animales y la distancia de transporte a una planta faenadora en la región de Ñuble, Chile, durante el periodo noviembre-diciembre de 2018. Se evaluaron 193 canales identificando categoría, grado de contusiones, sexo, peso y localidad de procedencia. El 76.2% (147/193) de las canales correspondían a machos y 23.8% (46/193) a hembras. Se observaron 152 contusiones, siendo principalmente grado 1 en el 55.4% (107/193), seguido de un 21.8% (42/193) de grado 2 y solo 1.6% de grado 3 (3/193), mientras que 21.2% (41/193) de las canales estaban libres de contusiones. Además, 83.4% (161/193) de las canales correspondieron a la categoría V. El mayor número de animales (76.8%) provino de distancias menores a 60 km. No se encontró asociación entre la distancia de viaje y la presencia de hematomas (p>0.05). Sin embargo, aunque la distancia de transporte no fue un factor influyente en la aparición de hematomas, el sexo (hembra) y el mayor peso por separado fueron más propensos a la aparición de hematomas (p<0.05).

Palabras clave: contusiones, canal bovina, matadero, categoría

INTRODUCTION

Before an animal is destined for slaughter, the factors that can affect the quality of the meat must be considered. These include stress, physical condition, origin, health, and transport, which affect both animal welfare (AW) and animal health and therefore meat quality (Romero et al., 2012). The effects on animal welfare can be assessed through physiological indicators, such as pre-feeding stress that generates lower muscle glycogen reserves affecting final pH (Soria and Corva, 2004), and behavioural indicators. Quantitative and qualitative effects on meat production are measured mainly through changes in live and carcass weight, as well as bruising (carcass damage), alterations in pH and meat colour (Sepúlveda et al., 2007).

Beef quality

Meat quality can be easily assessed by comparing organoleptic characteristics, such as colour, flavour, odour, texture, and the effects of freezing and chilling methods freezing and chilling methods (Teira *et al.*, 2006; Bethancourt-Garcia *et al.* 2019). The cellular aspects of the meat can affect the quality by the content of an inappropriate component or tissue damage (Romero *et al.*, 2011; Strappini *et al.*, 2011). Based on this, a comparison can be made between intensively and extensively produced meat; in the latter, the muscular characteristics and the quality of fat are better defined, but it has a shorter shelf life, altering organoleptic characteristics more quickly, thus reducing its useful life; while the meat generated by intensive production maintains the organoleptic characteristics better, and is therefore preserved for a longer period of time (Teira *et al.*, 2006; Miranda-de la Lama, 2013).

Animal welfare

It is essential to identify the factors that can affect animal health, animals must have the freedom to behave naturally. Besides, the animal must be free of fear and anguish, avoiding physical suffering, as well as not exposing them to conditions that lead them to experience alterations at a mental level (Grandin, 1997; Gallo and Tadich, 2005). In Chile, there are laws that demand accountability and sanction those who violate animal welfare (Gallo and Tadich, 2005).

Prior to slaughter there are factors and behaviours that generate stress in the animal: 1) increased handling, picking and herding with sharp or electric prods, 2) mixing of animals from different backgrounds and contact with strange personnel, 3) transport and physical challenges such as ramps, slippery surfaces, load density, movement, noise and vibration of the animal transport vehicle, 4) contact with new and unfamiliar environments, 5) deprivation of feed and water; 6) changes in social structure, 7) changes in climatic conditions such as temperature, radiation and humidity, 8) inability to rest, 9) conditions of illness and physical damage including bruising. These factors trigger reactions in the animal that result in physical, physiological, and psychological stress (Romero and Sanchez, 2012). On the other hand, as well as the type of cattle (European or Zebu) are important factors to consider as Zebu cattle are more fearful towards human presence but less aggressive towards each other compared to European cattle (Mendonça et al., 2016a).

All these factors influence the appearance of bruises, which are reflected in the carcass at the time of visual inspection once skinning has been carried out, leaving a decrease in meat quality due to expunges or elimination, thus resulting in a significant economic loss (Alende, 2010). This reflects alterations in animal welfare in cattle destined for slaughter, which must be avoided to have an efficient slaughter-breeding system (Pérez-Linares *et al.*, 2013).

Legislation and bruising

The bovine carcass is defined as the primary unit of meat, resulting from the animal once unsensitized, bled, skinned, eviscerated, with the head cut off at the level of the atlanto-occipital joint, without external genital organs and the limbs cut off at the level of the carpal metacarpal and tarsometatarsal joints. The carcass may only include the tail, pillars, and peripheral portion of the diaphragm (INN, 2002). The Chilean Standard (NCh) 1306 of 2002 for a long time evaluated the contusions through the typification of bovine carcasses. Currently the standard on beef carcass typing is NCh 1306 OF 2015, which has been modified by eliminating the evaluation of bruises, a situation that strongly affects the final quality of the product to be marketed. According to NCh 1306 of 2002, contusion is the crushing of tissues accompanied by vascular ruptures without skin discontinuity, which was classified into three grades that were differentiated according to the level of depth and tissue damage (INN, 2002).

Supreme Decree 240 (Decreto N.º 240, 2005) corresponds to the general regulations for the transport of livestock, where article 3 mentions that animals must be transported observing the corresponding hygienic-sanitary measures. The transporter must carry the appropriate documentation for the animal, and electric prods must not be used during transport. Article 4 indicates that the transport of bovines by land in trucks will only be authorised in vehicles that comply with specific requirements, avoiding stress, possible blows or injuries that can only be identified when the animal is in the slaughter process, reflected as contusions (Decreto N.º 240, 2005):

Due to the importance of injuries caused by handling during transport and prior to slaughter, it was considered necessary to analyse the impact of bruising in different categories, correlating them with each other, to quantitatively evaluate the animals affected by bruising and the predisposing factors. The hypothesis of this study was that the bruises detected in bovine carcasses occur mostly in whole animals, of greater weight and with a greater distance to destination. Therefore, the aim of this investigation was to relate the degree of bruising in bovine carcasses to the characteristics of the animals and the distance of transport in a slaughterhouse in the Ñuble region.

MATERIALS AND METHODS

The study was conducted in a slaughterhouse in the Ñuble Region, which slaughters an average of 800 cattle per month. Sampling (193 cattle carcasses) took place during the months of November and December 2018. The sample size was determined using WinEpi® software (De Blas, 2006) with a confidence level of 95% and a margin of error of 5%.

During the slaughter of the animal, the certifying body carried out the sampling procedure, which primarily considered the assignment of carcass class, by means of tooth chronometry (Table 1) and sex as established in the regulations. Subsequently, the carcass category was assigned, which considers the class and fat cover (INN, 2002; Romero *et al.*, 2010). Simultaneously, once the animal was skinned and eviscerated and by visual inspection, the presence or absence of bruises was evaluated, and if present, the degree of severity was determined (Table 2). In addition to this, data such as weight and locality of origin were provided to complement

Table 1. Nomenclature for eruption and levelling of teeth in cattle according to Chilean regulations (modified from Gallo *et al.*, 1999)

Nomenclature	Definition
DL	Eruption of milk teeth
DL+	Level milk teeth
2DP	Eruption of 2 permanent teeth (pincers)
4DP	Eruption of 4 permanent teeth (pincers and internal medium)
6DP	Eruption of 6 permanent teeth (pincers and medium)
8DP	Eruption of 8 permanent teeth
8DP+	Eruption of 8 permanent teeth and second level medium-sized teeth

the information and traceability of the animals. The carcass category corresponds to a grade assigned to the carcass of the bovine animal according to the sex of the animal and the dental chronometry, in addition to the fat cover (Table 3).

Carcass data were analysed by class, category, weight (kg), farm origin, presence, and degree of bruising. Contusions were quantified in absolute and relative terms considering the number of carcasses per category. The data collected were recorded in an Excel® spreadsheet and statistical analysis was performed using Infostat® 2019 software. Univariate descriptive statistics were also performed using maximum, minimum, average, and median.

RESULTS

According to the data obtained, of the 193 carcasses slaughtered, 74.6% (144/193) of the carcasses corresponded to castrated males, 1.6% (3/193) were entire males and 23.8% (46/193) were females, which resulted in a higher ratio of males to females.

The largest number of animals presented 2DP dental chronometry, with 44.6% of which the highest proportion of these were males, 39.9%. In the DL+ category there were 47 animals, of which 28 are males and in the 4DP category there are 29 animals, all of which were male. Females were represented in a smaller proportion (Table 4).

Data showed that 42 carcasses (21.8%) had no bruising on inspection. Grade 1 contusions were predominant in 106 (54.5%) of carcasses, mainly in 2DP males (42; 39.3%). Grade 2 contusions were observed in 42 (21.8%), mainly in 2DP castrated males. Grade 3 contusions were found in 3 (6% carcasses), with the most affected females were (2; 66.7%), one with 2 PD and the other with 8 PD+, suggesting that contusions in females may be more dispersed in age (Table 5).

Degree of bruising	Characteristics
First degree	Affect the subcutaneous tissue, reaching up to the superficial muscular aponeurosis, causing little appreciable injury.
Second degree	Those that have reached the muscular tissue, injuring it to a greater or lesser depth and extent. It will be observed that the affected region is haemorrhagic.
Third degree	Involve bone tissue. The muscle tissue generally appears friable with great serous exudation and normally with fracture of the bones in the affected area.

 Table 2.
 Grades of bruising on bovine carcasses according to Chilean regulations (INN, 2002; Romero et al., 2012)

Table 3.Category or typification and fat cover of bovine carcasses, class and dental chronometry of
bovine animals according to Chilean regulations related to meat certification (modified from
INN, 2002; Romero *et al.*, 2012)

Category	Class	Sex	Dental chronometry	Fat cover
V	Heifer	Female	DL+ - 2DP	1 - 2 - 3
	Young steer	Castrated male or intact	DL+ - 2DP	
	Young cow	Female	4DP	
	Steer	Castrated male	4DP	
	Young bull	Castrated intact	0+	
	Bull	Castrated intact	2DP	
	Toruno	Late castrated male	2DP	
	Young steer (>160 kg)	Castrated male or intact	0	
	Young heifer (>160 kg)	Female	0	
С	Young cow	Female	6DP	1 - 2 - 3
	Steer	Castrated male	6DP	
U	Adult cow	Female	8DP	1 - 2 - 3
	Old cow	Female	8DP+	
	Ox	Castrated male	8DP - 8DP +	
	Bull	Castrated intact	4DP - 6DP - 8DP - 8DP+	
	Toruno	Late castrated male	4DP - 6DP - 8DP - 8DP+	
Ν	All classes (except young heifer - young steer)		No requirements	0
0	Young heifer	Female	0	0-1-2-3
	Young steer	Castrated male or intact	0	

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Sev			De	ental chronor	metry, n (%	ó)		
SCA	DL^1	DL+	2DP	4DP	6DP	8DP	8DP+	Total
Female	8 ^a	17 ^a	9ª	$0^{\rm ND}$	2ª	6ª	4 ^a	46
	(4.2)	(8.8)	(4.7)	(0)	(1.0)	(3.1)	(2.1)	(23.8)
Male	$0^{\rm ND}$	30^{ab}	77 ^b	29 ^{ab}	3 ^a	5ª	3 ^b	147
	(0)	(15.5)	(39.9)	(15.0)	(1.6)	(2.6)	(1.6)	(76.2)
Total	8	47	86	29	5	11	7	193
	(4.2)	(24.4)	(44.6)	(15.0)	(2.6)	(5.7)	(3.6)	(100.0)

Table 4.Number and percentage of cattle carcasses according to tooth chronometry and sex in a
slaughterhouse in the Nuble region from November to December 2018 (n=193)

Different letters indicate significant difference (p<0.05) in the row. ND: not determined $^1\,{\rm For}$ nomenclature see Table 1

Table 5.	Distribution of cattle carcasses according to degree of contusion, tooth chronometry and sex
	in a slaughterhouse in the Nuble region, Chile, period November to December 2018 (n=193)

Sex /	ex / Degree of bruising frequency, n (%)					
dental chronometry		Free ¹	1	2	3	Total
Females	DL	1 (0.5) ^a	7 (3.6) ^a	0 (0) ND	0 (0) ND	8 (4.2)
	DL+	5 (2.6) ^a	9 (4.7) ^a	3 (1.6) ^a	0 (0) ND	17 (8.8)
	2DP	3 (1.6) ^a	5 (2.6) ^a	$0 (0)^{\rm ND}$	$1 (0.5)^{a}$	9 (4.7)
	6DP	0 (0) ND	2 (1.0) ^a	$0 (0)^{\rm ND}$	$0 (0)^{ND}$	2 (1.0)
	8DP	0 (0) ND	3 (1.6) ^a	3 (1.6) ^a	$0 (0)^{ND}$	6 (3.1)
	8DP+	$0 (0)^{ND}$	3 (1.6) ^a	0 (0) ND	$1 (0.5)^{a}$	4 (2.1)
Subtotal female		9 (4.7)	29 (15.0)	6 (3.1)	2 (1.0)	46 (23.8)
Castrated males	DL+	6 (3.1) ^a	15 (7.8) ^b	6 (3.1) ^a	1 (0.5) ^b	28 (14.5)
	2DP	19 (9.8) ^a	42 (21.8) ^b	16 (8.3) ^a	$0 (0)^{ND}$	77 (39.9)
	4DP	6 (3.1) ^a	15 (7.8) ^b	8 (4.2) ^a	$0 (0)^{ND}$	29 (15.0)
	6DP	$0(0)^{\text{ND}}$	2 (1.0) ^a	$1 (0.5)^{a}$	$0 (0)^{ND}$	3 (1.6)
	8DP	$0(0)^{\mathrm{ND}}$	2 (1.0) ^a	$2(1.0)^{a}$	$0 (0)^{ND}$	4 (2.6)
	8DP+	$1 (0.5)^{a}$	$1 (0.5)^{a}$	$1 (0.5)^{a}$	0 (0) ND	3 (1.6)
Intact males	DL+	$0(0)^{\text{ND}}$	0 (0) ND	$2(1.0)^{ND}$	0 (0) ND	2 (1.0)
	2DP	$0(0)^{\mathrm{ND}}$	$0(0)^{ND}$	0 (0) ND	0 (0) ND	0 (0)
	4DP	$0(0)^{\text{ND}}$	$0(0)^{ND}$	0 (0) ND	0 (0) ND	0 (0)
	6DP	$0(0)^{\text{ND}}$	$0(0)^{ND}$	0 (0) ND	0 (0) ND	0 (0)
	8DP	$1 (0.5)^{a}$	$0(0)^{ND}$	0 (0) ND	0 (0) ND	1 (0.5)
Subtotal male		33 (17.1)	77 (40.0)	36 (18.6)	1 (0.5)	147 (76.2)
Total		42 (21.8) ^b	106 (54.5) ^a	42 (21.8) ^b	3 (1.6)°	193 (100.0)

DP: Permanent teeth; DL: Milk teeth

^{a,b} Different letters indicate significant difference (p<0.05) between columns. ND: not determined

¹ Bovine carcass have no visible bruising at official certification

Catagory			De	ental chronon	netry, n (%	ó)		
Category	DL	DL+	2DP	4DP	6DP	8DP	8DP+	Total
V	0 (0)	47 (24.4)	86 (44.6)	29 (15.0)	0 (0)	0 (0)	0 (0)	162 (83.9)
С	0 (0)	0 (0)	0 (0)	0 (0)	5 (2.6)	0 (0)	0 (0)	5 (2.6)
U	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	10 (5.2)	7 (3.6)	17 (8.8)
Ν	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0.5)	0 (0)	1 (0.5)
0	8 (4.2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	8 (4.2)
Tatal	8	47	86	29	5	11	7	193
Total	(4.2) ^c	$(24.4)^{a}$	$(44.6)^{b}$	$(15.0)^{d}$	(2.6) ^c	(5.7) ^c	$(3.6)^{c}$	(100)

Table 6.Category of bovine carcasses according to tooth chronometry and category in a
slaughterhouse in the Nuble region, Chile, period November to December 2018 (n=193)

DP: Permanent teeth; DL: Milk teeth

¹ See Table 3 for definition of categories of carcasses

^{a,b,c,d} Different letters between columns indicate significant difference (p<0.05)

Table 7.	requency of bovine carcasses according to degree of bruising ¹ , category and sex in a	
	laughterhouse in the Ñuble region, Chile, period November to December 2018 (n=193)	

Category ² Sex			Deg	ree of bruising ¹		
		Free ³	1	2	3	Total
V	All	39	86	35	2	162
	Female	8	14	3	1	26
	Male	31	72	32	1	136
С	All	0	4	1	0	5
	Female	0	2	0	0	2
	Male	0	2	1	0	3
Ν	All	0	1	0	0	1
	Female	0	1	0	0	1
0	All	1	7	0	0	8
	Female	1	7	0	0	8
U	All	1	9	6	1	17
	Female	0	5	3	1	9
	Male	1	4	3	0	8
Total		41	107	42	3	193

¹See Table 2 for degree of bruising

² See Table 3 for definition of categories of carcasses

³ Bovine carcasses have no visible bruising at official certification

Data showed that 83.9% of the carcasses were categorised as V carcasses, of which 44.6% originated from young animals of 2DP, followed by those categorised as U with 8.8%, considering animals of 8DP (5.2%) and 8DP+ (3.6%). The remaining categories obtained low numbers of animals, (category C, 2.6%; category N 0.5%; category O;

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т. С. і і	Town of origin Degrees of bruising, n (
I own of origin	Free ¹	1	2	3	Total
Arauco	$0 (0)^{ND}$	1 (0.5) ^a	0 (0) ND	0 (0) ND	1 (0.5)
Bulnes	5 (2.6) ^a	11 (5.7) ^b	6 (3.1) ^a	0 (0) ND	22 (11.4)
Cauquenes	$1 (0.5)^{a}$	$1 (0.5)^{a}$	0 (0) ND	$0 (0)^{ND}$	2 (1.0)
Chillán	4 (2.1) ^a	12 (6.2) ^b	2 (1.0) ^a	0 (0) ND	18 (9.3)
Coelemu	$1 (0.5)^{a}$	3 (1.6) ^a	$1 (0.5)^{a}$	0 (0) ND	5 (2,6)
Coihueco	2 (1.0) ^a	3 (1.6) ^a	$1 (0.5)^{a}$	$0 (0)^{ND}$	6 (3.1)
El Carmen	6 (3.1) ^a	16 (8.3) ^b	5 (2.6) ^a	1 (0.52) ^a	28 (14.5)
Florida	$0 (0)^{ND}$	$1 (0.5)^{a}$	0 (0) ND	0 (0) ND	1 (0.5)
Longaví	$0 (0)^{ND}$	$1 (0.5)^{a}$	$0 (0)^{ND}$	$0 (0)^{ND}$	1 (0.5)
Los Ángeles	2 (1.0) ND	5 (2.6) ^a	$4(2.1.7)^{a}$	0 (0) ND	11 (5.7)
Mulchén	$1 (0.5)^{a}$	$2(1.0)^{a}$	$2(1.0)^{a}$	$0 (0)^{ND}$	5 (2.6)
Ninhue	$1 (0.5)^{a}$	$1 (0.5)^{a}$	0 (0) ND	0 (0) ND	2 (1.0)
Ñiquén	$1 (0.5)^{a}$	3 (1.6) ^a	2 (1.0) ^a	0 (0) ND	6 (3.1)
Pemuco	$1 (0.5)^{a}$	$0 (0)^{ND}$	0 (0) ND	0 (0) ND	1 (0.5)
Pinto	$1 (0.5)^{a}$	$1 (0.5)^{a}$	$1 (0.5)^{a}$	0 (0) ND	3 (1.6)
Quillón	3 (1.6) ^a	2 (1.0) ^a	0 (0) ND	$0 (0)^{ND}$	5 (2.6)
San Carlos	2 (1.0) ^a	9 (4.7) ^a	$4(2.1)^{a}$	0 (0) ND	15 (7.8)
San Ignacio	8 (4.2) ^a	31 (16.1) ^b	10 (5.2) ^b	2 (1.04) ^a	51 (26.4)
San Nicolás	$0 (0)^{ND}$	3 (1.6) ^a	2 (1.0) ^a	0 (0) ND	5 (2.6)
Trehuaco	$1 (0.5)^{a}$	$1 (0.5)^{a}$	0 (0) ND	$0 (0)^{ND}$	2 (1.0)
Yumbel	$1 (0.5)^{a}$	$0 (0)^{ND}$	2 (1.0) ^a	$0 (0)^{ND}$	3 (1.6)
Total	41 (21.2)	107 (55.4)	42 (21.8)	3 (1.55)	193 (100)

Table 8.Number of bovine carcasses by locality of origin and degree of bruising in a slaughterhouse
in the Ñuble region, Chile, period November to December 2018 (n=193)

See Table 2 for degree of bruising

^{a.b} Different letters indicate significant difference (p<0.05) between columns. ND: not determined

¹ Bovine carcass has no visible bruising at official certification

4.2%). Category O considers young animals weighing less than 160 kg or having 0 fat cover, so all carcasses in this category originate from animals with LD (Table 6).

The contusions related to the category indicated in Table 7 show that carcass category V had the highest percentage of affected carcasses, mainly grade 1 (86; 44.6%), followed by grade 2 (35; 18.1%). Of the total number of animals observed in category V (162; 83.9%), 39 (20.2%) had no bruises. In category U, 17 (8.8%) bovine carcasses were observed, of which 9 (4.7%) were bruised to grade 1 and 6 (3.1%) were bruised to grade 2. Table 9. Distance (km) from the farm to the slaughterhouse

Localities	Distance
	(km)
Bulnes	5
Chillán	26.3
El Carmen	35.5
San Ignacio	59,9
Arauco	161

The range of carcass weights is presented in Figure 1. The minimum weight corresponded to 126 kg in a young female DL, the maximum weight corresponded to 535 kg in



Figure 1. Cumulative absolute frequency of bovine carcass weight, in a slaughterhouse in the Nuble region, period November to December 2018 (n=193).

two males, 8DP and 8 DP+, while the overall average is 300.2 kg. The largest weight distribution was between 214 and 346 kg, most of which corresponds to category V males. On the other hand, 45% of the data corresponds to weights between 302 and 346 kg, weights above 390 kg were less frequent, mostly 8DP and 8DP+ females.

Table 8 shows the frequency and degree of bruising according to localities of origin. The localities around Bulnes were catalogued within a radius of 5 km being the closest, mainly because some animals come directly from the livestock fair. Among the 22 animals (11.4%) 11 (50.0%) have grade 1 contusions and 6 (27.3) grade 2. The locality with the most animals slaughtered (n=51; 26.4%) was San Ignacio (60 km distance) of which 31 (60.8%) had grade 1 contusions, 10 (19.6%) grade 2 and 2 (3.9%) grade 3. The localities with the greatest distance of animal transport were from Arauco (161 km distance), with 1ne (0.52%) grade 1 animal, and Cauquenes (142 km distance) with 1 animal classified with grade 1 contusion.

The distance travelled by each animal to the slaughterhouse was 51.8 km, mainly because most of the animals come from nearby localities with no more than 60 km and with a minimum travelling distance of 5 km (Table 9).

DISCUSSION

The groups of younger animals concentrate more males, mainly due to the fact that are sold in livestock fairs at an early age for slaughtering, being the optimal age of production around 1.5-2.0 years of age (up to 2DP) (Table 3). On the other hand, the productive life of females is longer, and they usually exceed 4 permanent teeth, around 3 years of age (Jarvis *et al.*, 1995; Zolezzi and Abarca, 2017).

Category U includes animals with a higher dental chronometry (8DP and 8DP+) and therefore older (INN, 2002). In general, they are cattle that are slaughtered at the end of their productive life. Carcasses on categories U or N implies an economic loss, as these have a lower commercial value compared to category V, because they are animals with weights and/or fat covers below the standards required by the usual buyers, or with some injury (bruising) that affects their category (Mendoça *et al.*, 2017).

Regarding the degrees of contusion (Table 5), it was evident that contusions in females are present regardless of tooth chronometry. In similar studies, the occurrence of grade 1 contusions was up to 97% (Romero *et al.*, 2012; Mendonça *et al.*, 2016b) while in the present study reached 54.6%. Table 6 shows that most of the bruises were present in animals classified as V, seriously affecting the quality of beef in case of bruises considered as 2 or 3 s (INN, 2002; Mach *et al.*, 2008).

There was 21.78% of grade 2 contusions, suggesting that the animals were exposed to stressful events, which can be associated with poor handling during loading and unloading of the animals, long journeys without adequate conditions for transport such as the availability of water and feed (Gallo, 2008; Mendonça *et al.*, 2017). The results of this study contradict the one reported by Villarroel (1997) focussed of dairy cattle in the Lakes region, where 50% of the animals were 8DP and 8DP+, 8.5 % were 4DP and 5.8% 6DP, while in the present study, focussed mainly on beef cattle, there were 15.0 and 2.6%, respectively.

In relation to the different grades of bruising, prior to 2015, carcasses with grades 2 and 3 were penalized without prejudice to the elimination or removal of the affected area (MINSAL, 2002). In the case of grade 2 bruising, the regulations indicated a reduction of one category if the carcass was assigned V, C or U. In the case of grade 3, the sanction was to penalize directly with category N (INN, 2002; Romero *et al.*, 2012). However, this sanction has been eliminated. Currently, it is left to the discretion of the official veterinary inspector and his experience, based on the principles of animal welfare.

The ideal slaughter weight for a steer is 400 kg live weight (Gallo et al., 2001) and considering the carcass yield between 54 and 58.5% according to Huerta-Leidenz (2013), the final carcass weight should range between 216 and 234 kg. In the present study the average weight of the 193 carcasses evaluated was 300.2 kg being the highest from 7 ox (449.3 g) and the lowest from 8 young heifers (143.4 kg). The weights recorded (Figure 1) of carcasses during this study are below those reported by Gallo et al. (2001, 2005) in Chile who reported average weight close to 400 kg. In that study live weight losses were 10-11% due to the transport time of around 36 h. However, this was not recorded in this study where the longest waiting times were in livestock fairs and slaughterhouse with free access to water and food.

One of the important factors in the occurrence of bruises on bovine carcasses is distance required for transport to the slaughterhouse (Gallo, 2008; Zanardi et al., 2022). The logistics and transport of animals are of vital importance for animal welfare, product quality and production efficiency (Miranda De La Lama, 2013; Zanardi et al., 2022). Table 8 shows the distance between the place of origin and the degree of bruising, and it can be observed that no significant differences were found (p>0.05) due to distance travelled and degrees of bruising. Data showed insufficient evidence to determine that the evaluated range of distance is a factor that could influence the appearance of bruises, which suggests that the place where bruises occur would be at the livestock fairs or slaughter plants prior to slaughter (Valadez et al., 2020).

In similar studies, females tend to have a higher tendency to present bruises in most of the parameters of transport time and time spent in places (Gallo, 2008; Romero *et al.*, 2012). Even so, both studies associates waiting time in slaughter plants and livestock fairs to a lower occurrence of bruises in males and females.

CONCLUSIONS

- In this study, grade 1 contusions were observed in a higher proportion in bovine carcasses regardless of the sex of the animals.
- Males of category V presented a higher frequency of grade 1 contusions.
- Sixty kilometres of transport was identified as a critical distance, although no relationship was found between the presentation of contusions in the carcasses and the distance of transport.

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