Acta Scientiarum
http://periodicos.uem.br/ojs
ISSN on-line: 1807-8672
Doi: 10.4025/actascianimsci.v44i1.55220

Economic loss from the main causes of whole bovine carcass condemnation in slaughterhouses supervised by the Federal Inspection Service in São Paulo state from 2010 to 2019

Rayane Marques Rodrigues[1], Thaiany Oliveira Martins[1] and Diego Pierotti Procópio[2*]

[1]Universidade Federal de Mato Grosso, Boa Esperança, Cuiabá, Mato Grosso, Brasil. [2]Universidade Federal de Mato Grosso do Sul, Av. Costa e Silva, s/n, 79070-900, Bairro Universitário, Campo Grande, Mato Grosso do Sul, Brasil. *Author for correspondence. E-mail: diego_pierottivrb@yahoo.com.br

ABSTRACT. The objective of this study was to analyze and determine the economic loss from the main causes of whole bovine carcass condemnation in slaughterhouses that are inspected by the Federal Inspection Service in the state of São Paulo for the period from 2010 to 2019. Economic loss was calculated from multiplication of the number of whole carcasses condemned by the mean yield of meat per carcass and the mean annual price of beef. The monetary values were updated to the year 2019, using the IGP-DI [General Price Index]. The results indicated an economic loss of R$ 4.06 billion from the whole condemnation of bovine carcasses and the main causes were contamination (R$ 1.73 billion), abscess (R$ 283.20 million), urinary cyst (R$ 194.14 million), emphysema (R$ 107.00 million) and nephritis (R$ 107.52 million). The main factors associated with the whole condemnation of bovine carcasses are failures in the pre-slaughter management and in the slaughter stages, as well as nutritional disorders. Consequently, to minimize such losses in beef production in São Paulo state it is recommended to adopt good production practices and train slaughterhouse employees.

Keywords: Agribusiness; abscess, bovine meat; contamination.

Received on August 12, 2020.
Accepted on February 16, 2021.

Introduction

Brazil stands out as one of the main beef producers, in 2019 the country reached a herd of approximately 214.89 million heads (Instituto Brasileiro de Geografia e Estatística [IBGE], 2021). Although the fragility of the commercial relationship between slaughterhouses and rural producers is prevalent, characterized by operations with payment terms of around 30 days resulting in high costs for working capital, the activity has seen a growing process of modernization (Macedo, 2006).

According to data from the Ministry of Agriculture, Livestock and Supply (2020), the total number of cattle slaughtered in abattoirs supervised by the SIF [Federal Inspection Service] of São Paulo was 2.76 million in 2019, corresponding to 11.27% participation in relation to the total Brazilian production.

In the process of food commercialization, characteristics such as flavor, appearance, absence of residues, texture, freshness and hygiene directly influence the choice of consumers regarding products of animal origin. Thus, consumers act as an incentive for the creation of marketing strategies among companies belonging to the beef production supply chain, aiming at competitiveness and sustainability (Brisola & Castro, 2005).

The guarantee of quality and safety for food of animal origin produced in Brazil is ensured through inspections carried out in the stages of antemortem and postmortem processing in slaughterhouses. The importance of the inspection service during the production process in the food processing industries is attributed to the objective of guaranteeing protection in the area of public health (Zweifel, Capek, & Stephan, 2014).

In the inspection process of production in slaughterhouses, if the carcass presents any problem that could compromise food safety, whole or partial condemnation may occur. Such condemnation represents financial losses for the production chains, since resources are no longer obtained from the non-commercialized products (Silva, Groff, Bassani, & Pianho, 2016).

The present work aims to determine and analyze the economic loss from the main causes of total condemnation of bovine carcasses in slaughterhouses supervised by the SIF in the state of São Paulo from 2010 to 2019.

Material and methods

For analysis of the main causes of whole condemnation of bovine carcasses in the state of São Paulo, the following variables were selected: (i) total slaughter of cattle; (ii) total condemnations of bovine carcasses; and (iii) the total number of condemnations of whole bovine carcasses due to a specific cause. The information was gathered from the SIF database considering the period from 2010 to 2019. To determine the economic loss, Equation 1 was used.

$$Economic\ loss_{per\ year} = QCC \times MYMC \times MAPA \quad (1)$$

Where: QCC = Quantity of Condemned (whole) Carcasses in the year; MYMC = Mean Yield of Meat per Carcass; and MAPA = Mean Annual Price per *Arroba* (@) [*Arroba* is a Brazilian unit of weight corresponding to 33 pounds] of bovine meat. The mean yield of meat per carcass is 16@ (Vaz et al., 2012). The series of prices per @ of bovine meat was taken from the Agrolink (2020) data base and the unit of measurement is R$/@. The price of beef was obtained from the annual average.

The nominal values of the economic loss during the period from 2010 to 2019 were updated using Equation 2, in accordance with the recommendations by Arbage (2012). The IGP-DI [General Price Index – Internal availability] published by the Fundação Getúlio Vargas (FGV, 2020) was used for the adjustment.

$$Real\ Value_{year} = \left(\frac{Nominal\ value_{year}}{IGP-DI_{year}}\right) \times IGP - DI_{base} \quad (2)$$

Where: Real value (year) = updated value of economic loss for the year 2019; Nominal value (year) = value of the economic loss calculated for each year from 2010 to 2019; IGP-DI (year) = General Price Index - Internal Availability for each year from 2010 to 2019; and IGP-DI (base) = General Price Index - Internal Availability for the year 2019.

Results and discussion

The state of São Paulo is a federative unit that has a significant participation in the number of cattle slaughtered in slaughterhouses supervised by the SIF in Brazil, with a mean 11.75% of the national total from 2010 to 2019 (Table 1).

Table 1. Quantitative slaughter of cattle in slaughterhouses under the supervision of the SIF in the state of São Paulo and Brazil from 2010 to 2019.

Year	São Paulo (units)	Brazil (units)	Production of São Paulo against national total (%)
2010	3,171,844	21,949,561	14.45
2011	2,916,510	21,815,821	13.37
2012	2,857,691	23,528,165	12.15
2013	3,018,073	26,105,193	11.56
2014	3,009,562	25,649,733	11.73
2015	2,611,995	22,941,797	11.39
2016	2,395,690	22,204,500	10.79
2017	2,406,077	23,171,759	10.38
2018	2,548,442	24,591,715	10.36
2019	2,764,480	24,531,017	11.27
TOTAL	27,700,364	236,489,261	11.75

Source: Elaborated using information from MAPA (2020).

In 2019, the Brazilian cattle herd was 214.89 million heads. Among the federative units, most of the herd was concentrated in Mato Grosso (31.97 million), Goiás (22.78 million), Minas Gerais (22.02 million), Pará (20.88 million), Mato Grosso do Sul (19.40 million), Rondônia (14.34 million), Rio Grande do Sul (11.96 million) and São Paulo with 10.48 million animals and representing about 4.87% of the national herd (IBGE, 2021).

In 2017, there were 2.52 million rural establishments with cattle in Brazil. Of this total, about 106,51 thousand rural properties were located in the state of São Paulo, which represents 4.22% of the national total (IBGE, 2021). The state of São Paulo has representativeness in the national scenario regarding the quantity of slaughters, size of the herd, and the number of rural establishments that exploit bovine livestock.

From 2010 to 2019, 27.70 million cattle were slaughtered in São Paulo slaughterhouses supervised by the SIF, with 1.71 million whole carcasses condemned (approximately 6.19% of the production) (Table 2).

Table 2. Total whole condemnation of bovine carcasses in São Paulo slaughterhouses supervised by the SIF from 2010 to 2019.

Year	Total condemnations
2010	148,856
2011	147,022
2012	143,098
2013	181,738
2014	193,688
2015	173,344
2016	131,459
2017	138,341
2018	226,235
2019	230,971
Total	1,714,752

Source: Elaborated using information from MAPA (2020).

The main causes of whole condemnation of bovine carcasses in São Paulo state were contamination, abscess, urinary cyst, emphysema and nephritis from 2010 to 2019, (Table 3).

Table 3. Prevalence, in percentage, of the main causes of whole condemnation of bovine carcasses in slaughterhouses supervised by the SIF in the state of São Paulo from 2010 to 2019.

Year	Contamination	Abscess	Urinary cyst	Emphysema	Nephritis
2010	30.06	0.31	0.02	0.00	0.00
2011	50.22	7.44	7.38	5.13	4.28
2012	52.57	7.90	5.70	4.97	3.88
2013	56.43	7.43	6.32	3.80	4.55
2014	51.91	9.18	8.96	2.67	3.58
2015	57.25	9.09	5.78	2.61	2.56
2016	54.30	9.56	6.44	4.73	4.01
2017	57.50	7.88	7.12	3.94	3.66
2018	59.18	8.28	6.97	2.68	2.51
2019	50.38	8.93	4.35	2.74	3.34
Mean	51.98	7.60	5.90	3.33	3.24

Note: The prevalence was determined from the ratio of total condemnations due to a specific cause against the total of whole condemnations for each year analyzed. Source: Elaborated using information from MAPA (2020).

The total economic loss from the whole condemnation of bovine carcasses in São Paulo state amounted to R$ 4.06 billion for the period from 2010 to 2019 (Table 4). Procópio (2019) found an economic loss of R$1.14 billion of the total condemnation of bovine carcasses in slaughterhouses supervised by the SIF for the state of Mato Grosso from 2007 to 2017.

Among the main causes of economic loss, the greatest was due to contamination, with a value of R$ 1.73 billion, followed by abscess (R$ 283.20 million), urinary cyst (R$ 194.14 million), emphysema (R$ 107.00 million) and nephritis (R$ 107.52 million) (Table 5).

In the new RIISPOA [Regulation for the Industrial and Sanitary Inspection of Products of Animal Origin] regulation, Decree 9.013 / 2017, Subsection I Art. 110 stipulates that animals slaughtered in an emergency are considered unfit for human consumption as in those cases of condemnation provided for in this Decree or in complementary norms (Brasil, 2017).

Table 4. Economic loss in Reals due to whole condemnation of bovine carcasses in slaughterhouses supervised by the SIF in São Paulo state from 2010 to 2019.

Year	Economic loss (R$ - Brazilian Reals)
2010	321,534,622.12
2011	345,137,988.95
2012	309,773,048.94
2013	382,958,473.40
2014	478,552,435.58
2015	475,801,832.89
2016	339,862,303,25
2017	329,827,830.37
2018	525,217,816.43
2019	560,502,222.28
Total	4,069,168,574.24

Source: Elaborated using information from Agrolink (2020), FGV (2020) and MAPA (2020).

Table 5. Economic loss, in Brazilian Reals, from the main causes of whole condemnation of bovine carcasses in slaughterhouses supervised by the SIF located in São Paulo state from 2010 to 2019.

Year	Contamination	Abscess	Urinary cyst	Emphysema	Nephritis
2010	96,653,062.03	12,982,378.47	77,764.66	4,320.26	4,320.26
2011	173,313,160.26	42,574,271.04	25,483,524.24	17,703,478.24	14,787,721.71
2012	162,859,341.28	24,460,577.86	17,662,966.17	15,392,044.31	12,025,711.13
2013	216,074,043.87	28,460,516.36	24,216,829.39	14,553,697.08	17,440,415.63
2014	158,442,375.47	28,022,342.11	27,354,167.94	8,142,584.73	10,914,562.00
2015	183,120,337.83	29,070,498.96	18,479,780.14	8,361,482.31	8,204,623.78
2016	117,828,040.67	20,743,466.60	13,972,043.71	9,006,553.70	8,712,718.19
2017	131,370,972.09	17,997,471.42	16,256,846.09	9,010,295.84	8,367,882.88
2018	245,968,296.18	34,422,408.28	28,959,058.81	11,158,165.6	10,416,002.50
2019	250,876,351.57	44,470,918.25	21,678,090.28	13,667,934.58	16,654,224.12
Total	1,736,505,981.26	283,204,849.35	194,141,071.45	107,000,556.69	107,528,182.20

Source: Elaborated using information from Agrolink (2020), FGV (2020) and MAPA (2020).

The main cause of whole condemnation of bovine carcasses in the state of São Paulo was contamination, with a mean prevalence of 51.98% from 2010 to 2019 (n = 1,714,752 cases). The whole condemnation of bovine carcasses due to contamination could arise from the internal environment of slaughterhouses or from external area of contamination in the carcass or a part of the animal's carcass by gastrointestinal content. Another factor listed is inadequate fasting time during the pre-slaughter stage as a contributing factor for condemnation due to gastrointestinal content. Furthermore, whole condemnation of the bovine carcass is determined whenever it is not possible to completely remove areas contaminated by urine, milk, bile, pus or other substances (Zweifel et al., 2014).

Pathogenic microorganisms belonging to the animals' natural microbiota are found on their external surfaces along with dirt, skin and fur, thereby reinforcing the need for hygienic-sanitary care during the stages of slaughter, processing and other industrialization and especially during the skinning stage (Silva & Bueno, 2018). Skinning activity is defined as the industrial process of removing the skin, a part of the animal considered to be unclean and which presents a risk of superficial contamination for the carcass (Zweifel et al., 2014).

Certain measures can reduce the frequency of whole condemnation of bovine carcasses due to contamination, such as compliance with the resting time, as well as fasting and water diet to avoid rupture of the digestive system (Procópio, 2019). Alternative care methods are also mentioned such as the spray bath which must be carried out with hyper-chlorinated water while ensuring that the animals arrive as dry as possible into the stunning box. Other precautions during the various slaughtering stages include care during stunning to avoid eventual ruminal reflux with the use of the pneumatic pistol, correct knife selection and sectioning must be effected when cutting internal vessels for bleeding. Likewise, skinning must be carried out with the animal suspended and verification to ensure the rectum and esophagus are tied during evisceration (Bonesi & Santana, 2008).

The second main cause of whole condemnation of bovine carcasses was the presence of an abscess, with a mean prevalence of 7.6% and a total of 145,313 cases from 2010 to 2019 (Table 3). An abscess is defined as a region in the animal's carcass with increased volume containing purulent contents (Castro & Moreira, 2010). The occurrence of abscesses is related to rumenitis caused by disorders such as ruminal acidosis, omphalophlebitis, reticulitis and traumatic reticuloperitonitis (Almeida, Silva, Torres, & Franque, 2017).

According to Brasil (2017), the occurrence of abscesses in organs, with the exception of the lung, leads to condemnation of the carcass, which can be partial or whole. Liver abscess is one of the main causes of condemnation of the viscera and the lesion most commonly found in slaughterhouses. In addition, abscesses lead to indirect losses in the beef cattle chain, such as reduced weight gain, impaired feeding efficiency and decreased growth rate (Nagaraja & Chengappa, 1998).

Urinary cyst was the third cause of whole condemnation of cattle in slaughterhouses supervised by the SIF in São Paulo state, with a mean prevalence of 5.9% and a total of 102,041 cases from 2010 to 2019 (Table 3). The occurrence of urinary cysts is associated with low fiber ingestion, limited water intake and high levels of phosphorus in the diet (Tigre, Leite, & Dias, 2012).

Pulmonary emphysema was the fourth leading cause of whole condemnation with a mean prevalence of 3.33% and a total of 54,583 cases between 2010 to 2019 (Table 3). Emphysema is divided into interstitial and alveolar, the interstitial arising from a violent increase in respiratory pressure that causes a rupture of the alveoli and the entry of air into the interstitial tissue. Alveolar pulmonary emphysema, on the other hand, is

defined as the distention and rupture of the alveolar walls, forming air bubbles in the lung. Both of these are injuries resulting from the slaughter process, mainly due to poor animal insensitizing (Marino et al., 2016).

Nephritis presented a mean prevalence of 3.24% (Table 3) and a total of 55,244 cases from 2010 to 2019, and is characterized as the fifth leading cause of whole condemnation of bovine carcasses in São Paulo. Nephritis is defined as an inflammation in the kidneys that presents in an acute or chronic form and manifests as an irregular kidney with whitish areas (Bonesi & Santana, 2008). When the carcass presents lesions due to nephritis or renal cysts, the kidney organ must be condemned, furthermore there must be an inspection to ascertain whether such lesions are related to parasitic or infectious diseases that can cause alterations and lead to whole condemnation of the carcass (Brasil, 2017).

According to Mendonça, Vaz, Costa, Gonçalves, and Moreira (2016), beef production has gone through a modernization process that seeks the differentiation of quality products due to the increase in the level of requirement from the consumer market. However, despite technological progress, there are logistical and management problems that contribute to the occurrence of losses along the process of adding value to the product. In this way, it becomes necessary to investigate which factors contribute to the occurrence of economic losses in the production chain to increase the level of sectoral competitiveness.

For Silva et al. (2016) and Silva, Oliveira, Kovaleski and Pagani (2020), the identification of the factors that contribute to the occurrence of total condemnations of bovine carcasses in slaughterhouses is important for the management of financial losses, as well as providing the necessary information for the improvement of the productive process of bovine slaughter, with improvements in the care of breeding management and pre-slaughter stage.

Part of the condemnations of bovine carcasses in slaughterhouses may be associated with the absence of an animal welfare program in the production process, which can result in the removal of affected areas of the carcass due to injuries caused by inadequate handling and stress situations of the animal (Petroni et al., 2013; Garcia, Fernandes, & Vaz, 2019).

In the state of São Paulo, total condemnations of bovine carcasses in slaughterhouses supervised by the SIF represent 6.19% of total slaughterings performed in the period from 2010 to 2019 (Tables 1 and 2). Therefore, it is recommended that this type of evaluation be performed out for the other federative units so that there is a dimension of this type of loss in the Brazilian beef production chain. These losses directly impact the amount of food that is offered to society and the minimization of such condemnations can contribute to the reduction of food and nutritional insecurity of the Brazilian population.

Conclusion

Therefore, it is recommended to carry out good production practices in the various slaughter stages, employee training and optimal conditions for pre-slaughter management and nutritional management are fundamental to minimize economic loss from total condemnations of bovine carcasses in São Paulo.

References

Agrolink. (2020). *Séries históricas*. Recovered from https://www.agrolink.com.br/cotacoes/historico/

Almeida, T. J. d. O., Silva, S. C. G., Torres, M. B. A. d. M., & Franque, M. P. (2017). Lesões macroscópicas e causas de condenação de carcaças e vísceras de bovinos abatidos ma microrregião de Garanhuns, Pernambuco, Brasil. *Medicina Veterinária (UFRPE)*, *11*(4), 292-300. DOI: https://doi.org/10.26605/medvet-n4-1959

Arbage, A. P. (2012). *Fundamentos de economia rural*. Chapecó, SC: Argos.

Bonesi, G. L., & Santana, E. H. W. (2008). Fatores tecnológicos e pontos críticos de controle de contaminação em carcaças bovinas no matadouro. *UNOPAR Científica. Ciências Biológicas e da Saúde*, *10*(2), 39-46.

Brasil. (2017). *Decreto Nº 9.013 de 29 de março de 2017*. Retrieved from https://bitlybr.com/fb7uA

Brisola, M. V., & Castro, A. M. G. d. (2005). Preferências do consumidor de carne bovina do Distrito Federal pelo ponto de compra e pelo produto adquirido. *Caderno de Pesquisas em Administração*, *12*(1), 81-99.

Castro, R.V., & Moreira, M. D. (2010). Ocorrências patológicas encontradas de rins e fígados bovinos em matadouro frigorífico do Triângulo Mineiro. *FAZU em Revista*, *7*, 159-163.

Fundação Getúlio Vargas. [FGV]. (2020). *Índices de preços*. Retrieved from http://portalibre.fgv.br/main.jsp?lumChannelId=402880811D8E34B9011D92B6B6420E96

Garcia, J. A. B., Fernandes, T. A., & Vaz, R. Z. (2019). Contusões em carcaças bovinas: fatores de ocorrência e influências do bem-estar animal na cadeia produtiva: revisão. *Medicina Veterinária (UFRPE)*, *13*(4), 620-628. DOI: https://doi.org/10.26605/medvet-v13n4-3673

Instituto Brasileiro de Geografia e Estatística [IBGE]. (2021a). *Censo Agropecuário de 2017*. Retrieved from https://sidra.ibge.gov.br/tabela/6907#resultado

Instituto Brasileiro de Geografia e Estatística [IBGE]. (2021b). *Pesquisa da Pecuária Municipal*. Retrieved from https://sidra.ibge.gov.br/tabela/74

Macedo, L. O. B. (2006). Modernização da pecuária de corte bovina no Brasil e a importância do crédito rural. *Informações Econômicas*, *36*(7), 83-95.

Marino, P. C., Bonesi, G. L., Negri Filho, L. C., Furlan, D., Augusto, D. N., Bogado, A. L. G., ... Okano, W. (2016). Lesões pulmonares de bovinos encontradas na inspeção *post-mortem* em matadouros frigoríficos no estado do Paraná. *Revista Brasileira de Higiene e Sanidade Animal*, *10*(4), 669-676. DOI: http://dx.doi.org/10.5935/1981-2965.20160053

Mendonça, F. S., Vaz, R. Z., Costa, O. A. D., Gonçalves, G. V. B., & Moreira, S. M. (2016). Fatores que afetam o bem-estar de bovinos durante o período pré-abate. *Archivos de Zootecnia*, *65*(250), 279-287. DOI: https://doi.org/10.21071/az.v65i250.500

Ministério da Agricultura, Pecuária e Abastecimento (2020). *Serviço de Inspeção Federal - SIF*. Retrieved from https://www.gov.br/agricultura/pt-br/assuntos/inspecao/produtos-animal/sif

Nagaraja, T. G., & Chengappa, M. M. (1998). Liver abscesses in feedlot cattle: a review. *Journal of Animal Science*, *76*(1), 287-298. DOI: https://doi.org/10.2527/1998.761287x

Petroni, R., Burger, K. P., Gonçalez, P. O., Rossi, G. A. M., Vidal-Martins, A. M. C., & Aguilar, C. E. G. (2013). Ocorrência de contusões em carcaças bovinas em frigorífico. *Revista Brasileira de Saúde e Produção Animal*, *14*(3), 478-484. DOI: https://doi.org/10.1590/S1519-99402013000300009

Procópio, D. P. (2019). Perda econômica das principais causas de condenações totais de carcaças bovinas em frigoríficos no estado de Mato Grosso de 2007 a 2017. Relato de Caso. *Revista Brasileira de Higiene e Sanidade Animal*, *13*(1), 106-114. DOI: http://dx.doi.org/10.5935/1981-2965.20190008

Silva, C. C. S., & Bueno, C. P. (2018). Pontos de contaminação de carcaças bovinas dentro do fluxograma de abate. *Nutritime Revista Eletrônica*, *15*(2), 8147-8152.

Silva, V. L. d., Groff, A. M., Bassani, C. A., & Pianho, C. R. (2016). Causas de condenação total de carcaças bovinas em um frigorífico do estado do Paraná. Relato de Caso. *Revista Brasileira de Higiene e Sanidade Animal*, *10*(4), 730-741. DOI: http://dx.doi.org/10.5935/1981-2965.20160060

Silva, V. L. d., Oliveira, G. D. d., Kovaleski, J. L., & Pagani, R. N. (2020). Custo de produção e perdas financeiras na bovinocultura de corte: um estudo de caso. *Custos e Agronegócio*, *16*(2), 152-171.

Tigre, J. S., Leite, P. A. G., & Dias, R. C. (2012). Principais causas de condenação de rins de bovinos que foram abatidos no Matadouro Municipal de Itabuna, Bahia. *Pubvet*, *6*(24), 1405-1410.

Vaz, F. N., Vaz, R. Z., Pascoal, L. L., Pacheco, P. S., Miotto, F. R. C., & Teixeira, N. P. (2012). Análise econômica, rendimentos de carcaça e dos cortes comerciais de vacas de descarte 5/8 hereford 3/8 nelore abatidas em diferentes graus de acabamento. *Ciência Animal Brasileira*, *13*(3), 338-345. DOI: https://doi.org/10.5216/cab.v13i3.17572

Zweifel, C., Capek, M., & Stephan, R. (2014). Microbiological contamination of cattle at different stages of slaughter in two abattoirs. *Meat Science*, *98*(2), 198-202. DOI: https://doi.org/10.1016/j.meatsci.2014.05.029