

Main causes of chicken carcass condemnations in Espírito Santo, Brazil

Principais causas de condenações de carcaça de frango no Espírito Santo, Brasil

Matheus Joaquim dos Santos Candido^{1*}; Surama Freitas Zanini²; Marcus de Freitas Ferreira²; Filipe Augusto Coimbra de Araujo¹; Alan Paulo Moreira Teixeira³; Raoni Cezana Cipriano⁴; Maria Augusta Pires da Luz Chieppe Moulim⁵

Highlights

The main causes of condemnations have a non-pathological origin.

Causes of condemnations by SIF are greater than those recorded by the SIE.

Major partial condemnations by SIF: bruises, dermatosis, contamination and myopathy.

SIF's condemnations: hemorrhagic viscera, cachexia, ascites and repulsive appearance.

SIE's condemnations: bruises/fractures, contamination, cellulitis and ascites.

Abstract

Brazil is the third largest producer and the main exporter of chicken meat in the world. In 2019, it produced approximately 13.245 million tons of the product, generating more than six million dollars. According to the Poultry Association of the state of Espírito Santo, broiler production is carried out by 28 independent producers/companies, three integrator businesses, 42 integrated producers and seven slaughterhouses (structures with SIF, SIE/SISBI or SIE certification). Despite the growth of this sector, problems persist regarding the quality of carcasses and the number of condemnations. From the sanitary and industrial point of view, all products of animal origin must undergo prior inspection. The present study was developed using data generated by the Federal Inspection Service (*Serviço de Inspeção Federal*, SIF) and the State Inspection Service (*Serviço de Inspeção Estadual*, SIE). The main causes of condemnation of birds as inspected by SIF represented 9.26% of the slaughtered birds. Total condemnations corresponded to 1.35%. Overall, this study recorded a greater number of condemnations of non-pathological origin. In conclusion, there was consistency in the reasons why these products were condemned. Bruises/fractures and contamination

¹ Veterinary Medicine Students, Federal University of Espírito Santo, UFES, Alegre, ES, Brazil. E-mail: mcandido0352@gmail.com; felipeaugls@hotmail.com

² Drs. in the Department of Veterinary Medicine, UFES, Alegre, Brazil. E-mail: smzanini@yahoo.com.br; marcusufes@gmail.com

³ Veterinarian, Animal Origin Products sub Manager in Institute of Agricultural and Forestry Defense, IDAF, Vitória, ES, Brazil. E-mail: alan.teixeira@idaf.es.gov.br

⁴ Veterinarian, Health Defense and Animal Inspection Manager, IDAF, Vitória, ES, Brazil. E-mail: rcipriano@idaf.es.gov.br

⁵ Veterinarian Graduate, UFES, Alegre, ES, Brazil. E-mail: maugustachieppe@gmail.com

* Author for correspondence

were the most frequent causes according to both inspection services (SIF and SIE), indicating a common problem on the slaughter and inspection lines.

Key words: Broilers. Condemnation. Control. Inspection.

Resumo

O Brasil é o terceiro maior produtor e o principal exportador de carne de frango do mundo. Em 2019, produziu aproximadamente 13,245 milhões de toneladas, faturando mais de seis milhões de dólares. Segundo a Associação dos Avicultores do Estado do Espírito Santo, a avicultura de corte conta com 28 produtores/empresas independentes, três integradoras, 42 integrados além de 7 abatedouros (estruturas com SIF, SIE/SISBI ou SIE). Embora tenha havido crescimento neste setor, ainda persistem problemas relacionados com a qualidade das carcaças e com o quantitativo de condenações. Sob o ponto de vista sanitário e industrial todos os produtos de origem animal devem receber fiscalização prévia. O presente trabalho foi desenvolvido mediante levantamento de dados gerados pelo Serviço de Inspeção Federal (SIF) e pelo Serviço de Inspeção Estadual (SIE). As principais causas de condenações de aves inspecionadas pelo SIF representaram 9,26% das aves abatidas. Para as condenações totais foi registrado o percentual de 1,35%. Este estudo registrou, no geral, um maior número de condenações de origem não patológica. Conclui-se que houve uma constância nas razões pelas quais esses produtos sofreram condenações. As contusões/fraturas e contaminações foram as de maior ocorrência, em ambos os Serviços de Inspeção (SIF e SIE), indicando um problema comum na linha de abate e inspeção.

Palavras-chave: Condenação. Fiscalização. Frango de corte. Inspeção.

Introduction

Chicken meat stands out worldwide for representing the combination of a high-quality food and a low price. According to the Brazilian Animal Protein Association (Associação Brasileira de Proteína Animal [ABPA], 2020), Brazil is among the top chicken producing and exporting countries. In 2018, the country held its first place in exports of chicken meat and reached second in production, with a total of 12.86 million tons (ABPA, 2019). In 2019, the country hit its own record of 13.245 million tons of chicken produced a growth of around 2.99%, making it the third largest world producer, with a per capita consumption of 42.84 kg and exports above 4,214 thousand tons. As such, it held its first place in this last classification, generating an additional six million Brazilian

reais with the product (ABPA, 2020). About 68.0% of all chicken meat produced in Brazil is destined for the supply of the domestic market and 32.0% is exported, mostly in the form of cuts (67%) and whole (26%), to regions such as Asia, Middle East and Africa. In this respect, the state of Espírito Santo stands out as one of the main exporters (ABPA, 2020). According to the Poultry Association of the state of Espírito Santo (*Associação dos Avicultores do Estado do Espírito Santo, AVES*), broiler production is developed by 28 independent producers/companies, three integrator businesses and 42 integrated producers in addition to seven slaughterhouses (structures under SIF, SIE/SISBI or SIE certification). In the State, the municipality of Domingos Martins ranks first in broiler production with 26.22% of the state production, followed by the municipalities of

Marechal Floriano (24.56%), Linhares (20.25%) and Venda Nova do Imigrante (11.68%), with the remaining municipalities accounting for 17.29% (Associação dos Avicultores do Estado do Espírito Santo [AVES], 2018). Partial data from the agricultural census released by the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística [IBGE], 2017) indicate that, between 2006 and 2017, poultry production in Espírito Santo grew by 115%. According to AVES, the gross revenue of the broiler production sector was over 560 million Brazilian reais.

Despite the growth of this sector, problems persist regarding the quality of carcasses and the number of condemnations, which raise a red flag due to the significant losses occurring in this sector in Espírito Santo.

In Brazil, the most widely used broiler strain is Cobb, most likely due to its greater growth potential, higher maturity rate and lower slaughter age, in addition to the pale pink color of its meat that guarantees its acceptance in the market (Santos et al., 2005). Other authors consider it the second best strain in (clean) carcass weight, bone-in and boneless breast, and boneless legs, only behind the Ross strain (Flemming, Janzen, & Endo, 1999). Despite the differences between the available commercial strains in the country, all have high carcass yields, with the final outcome depending on the genetic selection applied (Moreira et al., 2003).

From the sanitary and industrial point of view, all products of animal origin must undergo prior inspection, whether or not they are edible, include plant-based products and are prepared, processed, handled, received, in transit, packaged and/or stored (Lei nº 1.283, 1950). The Ministry of Agriculture, Livestock and Supply (MAPA) is responsible for the inspection

of animal products sold between states or/and internationally, through the Federal Inspection Service (*Serviço de Inspeção Federal*, SIF). Products with the described characteristics and which are distributed between municipalities are under the responsibility of the agricultural departments of the States, the Federal District and the Territories, and subject to the State Inspection Service (*Serviço de Inspeção Estadual*, SIE). As for sales within the municipality, the agriculture departments of the municipalities are responsible for inspection, under the so-called Municipal Inspection Service (*Serviço de Inspeção Municipal*, SIM). All of these are aimed at ensuring the quality of these products for the domestic and foreign markets (Lei n. 7.889, 1989). Inspection by the SIF agent at broiler slaughterhouses, for instance, takes place permanently in two stages, namely, *antemortem* and *postmortem*. *Antemortem* inspection has the purpose of preventing the slaughter of animals with a replete gastrointestinal tract and, consequently, possible contaminations during processing (Portaria nº 210, 1998). To avoid this type of condemnation, birds must be fasted for 6 to 8 h (Ebling & Basurco, 2016). Among the main factors that lead to condemnation by SIF in the state of Rio Grande do Sul are cachexia, repulsive appearance, cellulitis, bruises/fractures and contamination (Ferreira, Sesterhenn, & Kindlein, 2012).

In view of the lack of compilation of the information, interpretation and dissemination of results of great impact on the reality of Espírito Santo, this study was developed to determine the main causes of condemnation (partial and total) during the *postmortem* inspection of carcasses of broilers slaughtered at slaughterhouses inspected by SIF and SIE in the state of Espírito Santo.

Material and Methods

The present study was developed through a survey of data generated by SIF and SIE of Espírito Santo. The data include information from four slaughterhouses regularly registered with SIE, located in the municipalities of Cariacica, Marechal Floriano, Santa Maria de Jetibá and Vila Velha; and two registered with SIF, located in the municipalities of Linhares and Castelo. The establishments inspected by SIF received birds from 14 municipalities in the State, namely, Alfredo Chaves, Brejetuba, Cachoeiro de Itapemirim, Castelo, Conceição do Castelo, Domingos Martins, Guarapari, Jaguaré, Linhares, Marechal Floriano, Muniz Freire, Sooretama, Vargem Alta and Venda Nova do Imigrante. This data collection took place in the period from January 2018 to December 2019.

The postmortem inspection procedure for chickens is carried out in accordance with the Regulation for Industrial and Sanitary Inspection of Animal Products (Decreto nº 9.013, 2017) and Ordinance No. 210 of November 1998 of MAPA. The inspection is performed by visual and olfactory examination and by palpating the carcasses and their respective viscera, on the so-called "inspection lines" ("A" - internal examination of the carcass - opening and viewing of the coelomic cavity; "B" - examination of viscera; and "C" - external examination of the carcass).

Causes of condemnation (partial and total) as determined by SIF and SIE under Ordinance 2010/98 are abscess, airsacculitis, arthritis, repulsive appearance, cachexia, cellulitis, colibacillosis, contamination, bruises/fractures, dermatosis, overscalding, delayed evisceration, neoplasms, salpingitis, ascites, hemorrhagic syndrome and septicemia.

In the analysis of the condemnations at slaughterhouses registered only with SIE, improper bleeding procedure and other causes are identified. In the analysis of condemnations at slaughterhouses registered only with SIF, ascites, bloody meat, coligranulomatosis, abnormal color, technological flaws, skin lesion, inflammatory lesion, traumatic lesion, myocarditis, myopathy, dorsal cranial myopathy, nephritis, hemorrhagic viscera and pericarditis were considered.

The obtained information was used to rank the causes of partial and total condemnations by the respective inspection services according to the changes found and frequency of occurrence in the studied period as well as compare them with other data described in the literature of other Brazilian states.

Data were compiled on a nosographic map with the following criteria: diagnosis (pathologies) and year of evaluation with respective partial and total condemnations. Subsequently, the four main condemnations by SIE and SIF were analyzed. Statistical analysis was performed descriptively using the relative and absolute frequencies of condemnations, whose results are presented in the form of tables.

Results and Discussion

The main causes of poultry condemnation at slaughterhouses can have health or management origins or may occur during slaughter and processing (Maschio & Raszl, 2012). Tables 1 and 2 show the total number of birds slaughtered in establishments inspected by SIF and SIE, with the respective partial and total condemnation rates. From

January 2018 to December 2019, a total of 73.547 million broilers were slaughtered in establishments inspected by SIF in Espírito Santo. In facilities under State Inspection, the number of birds slaughtered reached 32.548 million. Of the total number of birds inspected by SIF, 6,677,872 exhibited some type of partial condemnation (Table 3), which represented 9.26% of the slaughtered birds. A total of 977,361 cases of total condemnation (Table 4) (1.35%) was recorded. When total and partial condemnations are added up, 7,655,233 chickens were found to have some deviation, which corresponds to slightly over 10% of the total number of birds slaughtered by facilities under SIF. Maschio and Raszl (2012) and Ferreira et al. (2012) reported that the partial condemnation rate was higher than the total condemnation rate, as observed in this study. In the slaughterhouses inspected by SIF, the partial condemnation rate reached 87.81%, whereas the total was 12.77%, which are lower than the 97.22% (partial) and higher than the 2.78% (total) found by Maschio

and Raszl (2012). The criteria for these condemnations were based on Ordinance No. 210 of November 1998 of MAPA. These values refer only to postmortem condemnations and do not include animals that died on the farms or during transport for SIF assessment. The results obtained in the present study (Table 1) are above the average partial and total condemnations reported by Paschoal, Otutumi and Silveira (2012) and Goscinski (2016), which ranged from 7 to 8%. As for the data on condemnations (partial and total) of broilers slaughtered at establishments inspected by SIF, 2,054,937 cases (6.30%) had some type of *postmortem* condemnation (Table 5). These results differ from the findings published by Dias et al. (2017), who observed that, of a total of 515,582 thousand birds slaughtered in a slaughterhouse under SIF in Espírito Santo, 87,423 thousand (16.95%) showed some type of *postmortem* condemnation. It is worth noting that until 2019, the SIF in Espírito Santo did not provide data on condemnations categorized as partial and total.

Table 1

Total and partial condemnations of broiler carcasses in establishments inspected by the Federal Inspection Service (SIF) of the state of Espírito Santo, between January 2018 and December 2019

Period	Partial condemnations		Total condemnations		Number of slaughtered chickens
	N	%*	N	%	N
2018	2,888,375	8.15	653,482	1.84	35,453,511
2019	3,946,876	10.36	323,879	0.85	38,094,325
Total	6,677,872	9.26	977,361	1.35	73,547,836

* Calculation based on the number of slaughtered birds.

Table 2
Condemnations of broiler carcasses in establishments inspected by the State Inspection Service (SIE) of the state of Espírito Santo, between January 2018 and December 2019

Period	Condemnations (partial and total)		Number of slaughtered chickens
	N	%*	N
2018	824,685	5.27	15,645,171
2019	1,230,252	7.32	16,813,091
Total	2,054,937	6.30	32,458,262

* Calculation based on the number of slaughtered birds.

Table 3
Changes in the broiler carcass as assessed by the Federal Inspection Service (FIE), suggestive of condemnation (partial and total), and their respective number, between January 2018 and December 2019

Diagnosis	N	%*	%**
Abscess	114,727	0.15	1.72
Airsacculitis	8,532	0.01	0.12
Arthritis	110,130	0.14	1.65
Ascites	10,450	0.01	0.15
Repulsive appearance	9,674	0.01	0.14
Cachexia	189	0.00	0.00
Bloody meat	5	0.00	0.00
Cellulitis	181,618	0.24	2.72
Colibacillosis	38,051	0.05	0.56
Contamination	375,222	0.51	5.61
Bruises	4,357,287	5.92	65.25
Dermatosis	1,015,266	1.38	15.19
Overscalding	94	0.00	0.00
Technological flaws	38	0.00	0.00
Skin lesions	863	0.00	0.01
Inflammatory lesions	89,331	0.12	1.34
Myocarditis	664	0.00	0.00
Dorsal cranial myopathy	47,335	0.06	0.71
Myopathy	218,721	0.29	3.28
Neoplasia	5	0.00	0.00
Pericarditis	23,871	0.03	0.35
Salpingitis	18,560	0.02	0.28

* Calculation based on the number of slaughtered birds.

** Calculation based on the number of partially condemned birds.

Table 4

Changes in the broiler carcass as assessed by the State Inspection Service (SIE), suggestive of condemnation (partial and total), and their respective number, between January 2018 and December 2019

Diagnosis	N	%*	%**
Repulsive appearance	68,500	0.09	7.00
Airsacculitis	15	0.00	0.00
Muscle changes	12	0.00	0.00
Arthritis	1	0.00	0.00
Cachexia	97,755	0.13	10.00
Bloody meat	6,400	0.00	0.65
Cellulitis	149	0.00	0.01
Colibacillosis	4216	0.00	0.43
Coligranulomatosis	19	0.00	0.00
Abnormal color	353	0.00	0.03
Contamination	2	0.00	0.00
Bruises	22	0.00	0.00
Dermatosis	354	0.00	0.04
Overscalding	104,078	0.14	1.64
Delayed evisceration	2,062	0.00	0.21
Technological flaws	63	0.00	0.00
Traumatic lesions	2	0.00	0.00
Myopathy	2,078	0.00	0.21
Dorsal cranial myopathy	6,537	0.00	0.66
Nephritis	964	0.00	0.09
Neoplasia	454	0.00	0.04
Salmonellosis	231	0.00	0.02
Salpingitis	7,529	0.01	0.77
Septicemia	1,433	0.00	0.14
Ascites	85,372	0.11	8.73
Hemorrhagic syndrome	15	0.00	0.00
Hemorrhagic viscera	574,305	0.78	58.76

* Calculation based on the number of slaughtered birds.

** Calculation based on the number of totally condemned birds.

Table 5
Changes in broiler carcasses as assessed by the State Inspection Service (SIE), suggestive of condemnation (partial and total), and their respective number, between January 2018 and December 2019

Diagnosis	N	%*	%**
Abscess	88	0.00	0.00
Airsacculitis	9,809	0.03	0.47
Arthritis	411	0.00	0.02
Repulsive appearance	27,904	0.08	1.36
Cachexia	29,706	0.09	1.45
Cellulitis	70,319	0.22	3.42
Colibacillosis	5,738	0.01	0.28
Contamination	220,715	0.67	10.74
Bruises/fractures	1,388,161	4.28	67.55
Dermatosis	10,527	0.03	0.51
Overscalding	17,425	0.05	0.84
Delayed evisceration	12,963	0.03	0.63
Neoplasias	169	0.00	0.00
Salpingitis	27,460	0.08	1.34
Improper bleeding procedure	9,780	0.06	0.48
Septicemia	14,811	0.03	0.72
Ascites	40,758	0.12	1.98
Hemorrhagic syndrome	0	0.00	0.00
Died during transport	70,518	0.21	3.43
Other causes	97,675	0.30	4.75

* Calculation based on the number of slaughtered birds.

** Calculation based on the number of condemned birds (partial and total).

Table 6 shows the main changes considered partial condemnations by the SIF and the respective numbers of condemnations per diagnosis. The most frequent were bruises (5.92%), dermatosis (1.38%), contamination (0.51%) and myopathies (0.29%). These data do not corroborate the information found by Maschio and Raszl (2012) and by Ferreira et al. (2012), who found arthritis and cellulitis, respectively, as prominent causes, which was not observed in the current study. Bruises/

fractures and contamination lead the indices in studies, even when these are carried out in different regions of the country. The origins of these condemnations are extrinsic to birds and consist of problems of handling and operational adjustments during the phases of production, slaughter and processing, as described by Mendes and Komiyama (2011) and Rossi (2020). As an example, bruises can occur due to improper handling in picking, loading and transporting the animals. Kettlewell and Turner

(1985) reported that bruises occur because birds are still hung manually and this practice depends directly on workforce, who may not be properly trained. Rossi (2020) also described that the wings and drumstick are the main affected regions, presenting a hemorrhagic aspect macroscopically, with a bright red,

dark or greenish color, depending on the evolution of the fracture, and that there may be conditions that contribute to the appearance of the lesion. In addition, according to Leandro, Rocha, Stringhini and Fortes (2001), picking the birds by the neck results in a higher incidence of bruises than by grabbing by their back.

Table 6

Main causes of partial condemnations of broilers in establishments in Espírito Santo inspected by the Federal Inspection Service (SIF) between January 2018 and December 2019

Year	Bruises		Dermatosis		Contamination		Myopathy	
	N	%*	N	%*	N	%*	N	%*
2018	2,042,754	70.72	441,260	15.28	117,861	4.08	30,408	1.05
2019	2,314,533	58.64	574,006	14.54	257,561	6.53	188,313	4.77
Total	4,357,287	64.68	1,015,266	14.91	369,422	5.31	218,721	2.91

* Calculation based on the number of partially condemned birds.

Dermatoses, on the other hand, refer to a group of diseases and changes that can occur in the skin tissue, such as increased skin thickness, color changes and surface alterations with the appearance of erosions, ulcers and nodules (Saif, 2003; Oliveira, Andrade, Armendaris, & Bueno, 2016). The appearance of this pathology is related to reuse of litter (Gundim, Rodrigues, Blanca, Coletto, & Medeiros, 2015), heavy chickens, excessive litter moisture and high stocking rates (Rossi, 2020).

Contaminations would be due to a lack of regulation of the evisceration machinery, which ends up causing the viscera to rupture and their content to leak, or non-uniformity of the lot, with birds of different sizes (Maschio & Raszl, 2012; Rossi, 2020). Contamination may be of fecal or biliary origin, in the latter case stemming from a rupture of the gallbladder,

which can be located both on the surface of the carcass and internally. It is also important to mention that fecal contamination represents a high risk to the health of the consumer, since most pathogens are found in the intestine. An important pathogen in this group is *Campylobacter jejuni*, which is reported to occur at a high frequency in other countries and which is underreported in Brazil due to low outbreaks, besides *Salmonella* spp (Rossi, 2020). To prevent this type of occurrence, it is also necessary to empty the intestine in the pre-slaughter period and it is recommended that water and feed not be removed simultaneously (Mendes & Komiyama, 2011).

In the data provided by MAPA, condemnation due to myopathy is separated into two categories, as described in Table 4: myopathy itself and dorsal cranial myopathy. This pathology can be defined by a reduction of

the blood supply and consequent appearance of alterations such as degeneration, fibrosis and necrosis of the muscle tissue. It is worth emphasizing that the condition is not linked to any infectious agent (Bilgili & Hess, 2008). As stated by Hoving-Bolink, Kranen, Klont, Gerritsen and Greef (2000), chickens that have a higher breast muscle yield tend to show problems related to low oxygenation, since there is reduced capillary density. Agreeing with this idea, Joiner, Hamlin, Lien and Bilgili (2014) reported that with the advance of age, muscle fibers tend to enlarge while blood capillaries reduce in quantity, in association with marginalization of vascular support on myofibers, which is important for fast-growing animals. The pectoral muscle of birds is mostly made up of white fibers. Therefore, their muscle fibers have a larger diameter and are surrounded by smaller capillaries, consequently having less oxygen than red fibers, which constitutes an adaptation to anaerobic metabolism (Santiago, 2001). Due to the characteristics of this musculature, some factors such as rapid growth and increased pectoral muscle resulting from selective breeding carried out over the last few years allow the development of muscle injuries as a result of reduced supply of nutrients

and oxygen and slow removal of the lactic acid produced (Hoving-Bolink et al., 2000). Although myopathy has been described by Assis, Sabino, Silva and Fontes (2019) as a real problem for chicken slaughter establishments, there is a shortage of studies reporting this pathology in prominence.

Table 7 shows the most frequent changes that led to total condemnations by SIF and the respective numbers of condemnations per diagnosis. Hemorrhagic viscera (0.78%), cachexia (0.13%), ascites (0.11%) and repulsive appearance (0.09%) stood out. Our results partially corroborate the findings of Maschio and Raszl (2012), who reported that ascites (0.06%), colibacillosis (0.04%) and improper bleeding procedure (0.03%) were the main causes of total condemnations.

According to Mendes and Komiyama (2011) and Ebling and Basurco (2016), hemorrhagic viscera fall within the causes related to slaughter and processing. This occurrence may be linked to problems during the bleeding procedure due to deregulation of the stunning equipment, whose amperage and voltage should be adjusted according to the weight of the lots (Mendes & Komiyama, 2011).

Table 7

Main causes of total condemnation of broilers in establishments in Espírito Santo inspected by the Federal Inspection Service (SIF) between January 2018 and December 2019

Year	Hemorrhagic viscera		Cachexia		Ascites		Repulsive appearance	
	N	%*	N	%*	N	%*	N	%*
2018	496,569	75.99	55,549	8.50	39,527	6.05	35,652	5.46
2019	77,736	24.00	42,206	13.03	45,845	14.15	32,848	10.14
Total	574,305	50.00	97,755	10.77	85,372	10.10	68,500	7.80

* Calculation based on the number of totally condemned birds.

Cachexia, also known as “malabsorption syndrome” or “runting stunting syndrome”, has its destination dictated in accordance with annex IX, article 232, Ordinance No. 210 of November 1998 of MAPA, which informs that all “cachectic animals should be condemned, regardless of the causes linked to the malnutrition process”. Kotler (2000) highlights the role of malnutrition as an inducer of destabilization of the immune system and predisposition to the emergence of infectious diseases. A poor diet may be associated with various situations, such as environmental temperature, wind, lighting program, toxins, anxiety and pathogens (Tinôco, 2001). These factors may be responsible for the production of cytokines capable of stimulating proteolysis. The percentage found in this study (0.13%) is higher than the 0.06% found by Almeida, Assis, Mendonça and Rolim (2017) in the northeast region of Brazil. Even though cachexia is one of the main causes of total condemnations, it was found at relatively low values, as in the study of Ferreira et al. (2012) (around 0.17%) and Paschoal et al. (2012) (around 0.026%). Other researchers, e.g., Maschio and Raszl (2012), do not even describe cachexia as a prominent cause, as it represented 0.001% of the annual slaughter.

Carcasses are classified as repulsive when they have a poor appearance, exhibit an abnormal color or exude medicinal, fecal, sexual or other odors deemed abnormal, and should be considered in the condemnation of birds. This includes game birds that display putrefactive changes, giving off a sulfurous-ammoniacal odor, revealing gas crepitation on palpation or changes in muscle color (Decreto nº 9.013, 2017). The most frequent forms of alteration observed in the carcasses of chickens is a change in the color throughout

the carcass musculature to a dark red shade, with a hard consistency and dry appearance, also known as DFD (dark, firm, dry) or PSE (pale, soft, exudative) meat, neither of which poses risks to human health. Both abnormalities are associated with chronic and acute pre-slaughter stress in broilers (Langer, 2007).

The current data are partially similar to those found by Paschoal et al. (2012) in a slaughterhouse located in the northwest of Paraná. In their study, the authors did not observe hemorrhagic viscera or ascites as the main causes of condemnation. However, repulsive appearance (47.33%) was the most important cause of condemnation in their study, whereas in the current investigation this condition was observed in 7.80% of the total fully condemned birds. In the survey carried out by Ferreira et al. (2012) in an establishment located in Rio Grande do Sul, repulsive appearance was the third major cause of condemnation, representing 19.4%, whereas the first was contamination (32%). Total condemnation was not a prominent finding in Espírito Santo by SIF.

Table 8 shows the predominant changes that led to the condemnation of chicken carcasses by SIE and the respective number of condemnations per diagnosis. The major causes of condemnation were bruises/fracture (4.28%), contamination (0.67%), cellulitis (0.22%) and ascites (0.12%). The highest percentage of condemnation was found for bruises/fractures, which represented 66.95% of condemned carcasses. These condemnation types were also observed by Dias et al. (2017), who showed that the most frequent in a slaughterhouse in Espírito Santo were bruises/fractures (47.83%), followed by dermatosis (17.36%) and, finally, contamination (17.24%). For Rossi (2020), bruising is a great

indicator that the handling from bird collection in the shed to their transport for slaughter is flawed and failing to respect the rules of animal welfare. As for contamination, the factors that promote the appearance of this technopathy according to SIE are different from those

described by SIF, as the procedure is performed manually in the state service. Therefore, contamination in these establishments, may originate from a lack of training of operators for the applied techniques.

Table 8
Main causes of condemnation (partial and total) of broilers in establishments in Espírito Santo inspected by the State Inspection Service (SIE) between January 2018 and December 2019

Year	Bruises		Contamination		Cellulitis		Ascites	
	N	%*	N	%*	N	%*	N	%*
2018	527,342	63.94	111,266	13.49	31,873	3.86	13,282	1.61
2019	860,819	69.97	109,449	8.90	38,446	3.13	27,476	3.33
Total	1,388,161	66.95	220,715	11.20	70,319	3.50	40,758	2.47

* Calculation based on the number of condemned birds (partial and total).

Cellulitis is a disease with a multifactorial etiology. It is characterized by acute and diffuse purulent inflammation of the subcutaneous tissue that destroys tissue planes and may involve muscle layers and the development of perihepatitis, salpingitis and arthritis (Berchieri & Macari, 2000). A noteworthy fact regarding this disease is that *Escherichia coli* will likely be present in most cases. Factors such as bird strain, nutrition, stocking rate, distance between feeders and drinkers, litter type, feed restrictions and lighting programs can affect the incidence and severity of this problem (Mendes & Komiyama, 2011). These authors reported that the use of chelated minerals, especially zinc, associated with adequate supplementation of vitamin E, has yielded good results in the control of cellulitis in broilers.

It is important to emphasize that ascites is not a disease, but a pathological condition that is characterized by leakage of fluid

from blood vessels and accumulation in the abdominal cavity. In the analysis carried out by Almeida et al. (2017), the authors observed its occurrence in 0.07% of the slaughtered birds. A similar result was found in the present study, where the cases corresponded to 0.12% of birds slaughtered and 1.98% of condemned chickens.

Regarding the financial impacts that each condemnation generates for slaughterhouses and, consequently, for the producer, a study by Maschio & Raszl (2012) in a slaughterhouse located in the south of Brazil under SIF inspection concluded that, partial condemnations (considering those found in the current study) can cause losses of up to 664,840 thousand Brazilian reais a year. This is without considering dermatosis, as the study did not provide information on this condemnation and its impacts. In terms of total condemnations, an annual loss of 253,217

thousand Brazilian reais is estimated if we disregard hemorrhagic viscera, which stood out in the present study as the prevailing cause of total condemnation. This information clearly shows that even though the percentages for some condemnations are relatively low (e.g., repulsive appearance: 0.09%), the economic impact can be high. This was also noted by Maschio and Raszl (2012), who stressed that losses can reach R\$67,287 annually. Therefore, a broad and skillful perspective within the slaughterhouse is mandatory, as are actions aimed at minimizing these occurrences. It noteworthy that the state of Espírito Santo lacks information on the economic impacts caused by condemnations, warranting further studies on the subject.

Overall, the partial and total condemnation rates of birds slaughtered at establishments inspected by the Federal Service were higher than the occurrences in establishments under State Inspection. Condemnations due to bruises/fractures and contamination were the most common by both Inspection Services. Almeida et al. (2017) grouped the causes of condemnations into pathological and non-pathological. Among the non-pathological causes (i.e., those that are directly related to handling, labor and equipment) are bruises/fractures, contamination and repulsive appearance, which, in this study, amounted to 77.79% of the birds condemned (partially and totally) by SIF. In the case of SIE, bruises/fractures, contamination, as well as birds dead during transport are also included (3.66%), which represent 81.81% of condemned birds (partial and total). These data are extremely relevant, as they demonstrate that condemnations can be drastically minimized through actions aimed at adjusting slaughtering techniques and

equipment as well as training the employees. In this way, the handling of the chickens will not have negative impacts on production, and animal welfare will be ensured from their collection on the farm to their transport, slaughter and processing. Additionally, with these data, calculations can be performed to elucidate the team on how much is lost with each condemnation, raising awareness and thus reducing condemnations and increasing profits throughout the production chain (Gundim et al., 2015; Ebling & Basurco, 2016).

Conclusion

The main causes of partial condemnations of broiler carcasses in the establishments inspected by the Federal Inspection Service in the state of Espírito Santo are bruises, dermatoses, contamination and myopathies. For the total condemnations, of the 977,361 cases, the presence of hemorrhagic viscera, malabsorption syndrome, ascites and repulsive appearances, together, represented 825,932 occurrences. In establishments inspected by SIE, the main causes of condemnation (partial and total) were bruises/fractures, contamination, cellulitis and ascites.

There was consistency in the reasons why these products were condemned. Bruises/fractures and contamination were the most frequent causes by both Inspection Services (SIF and SIE), indicating a common problem in pre-slaughter management and on the slaughter and inspection lines, which should receive greater attention from the industry to minimize losses caused by the disposal of these products.

Acknowledgements

Acknowledgements for their financial support National Council for Scientific and Technological Development (CNPq), National Council for the Improvement of Higher Education (CAPES) and the Espírito Santo Research Foundation (FAPES).

References

- Almeida, T. J. de O., Assis, A. S. de., Mendonça, M., & Rolim, M. B. de Q. (2017). Causas de condenação de carcaças de *Gallus gallus domesticus* em abatedouros frigoríficos sob Inspeção Federal no Nordeste do Brasil. *Revista Medicina Veterinária (UFRPE)*, 11(4), 7-27. doi: 10.26605/medvet-n4-1958 Recuperado de <http://www.journals.ufrpe.br/index.php/medicinaveterinaria/article/view/1958/482482581>
- Assis, B. V. de, Sabino, L. F., Silva, L. F. da & Fontes, R. A. (2019). Prevalência de miopatia dorsal e miopatia peitoral profunda no abate de frangos em um abatedouro frigorífico localizado em Minas Gerais. *Anais do Fórum Acadêmico da Faculdade Vértice-Univértix*, Matipó, MG, Brasil, 12. Recuperado de <https://fave.univertix.net/wp-content/uploads/2019/11/R119-P1.pdf>
- Associação Brasileira de Proteína Animal (2019). *Relatório anual*. Recuperado de <http://abpa-br.org/wp-content/uploads/2019/08/Relat%C3%B3rio-Anual-2019.pdf>
- Associação Brasileira de Proteína Animal (2020). *Relatório anual*. Recuperado de http://abpa-br.org/wp-content/uploads/2020/05/abpa_relatorio_anual_2020_portugues_web.pdf
- Associação dos Avicultores do Estado do Espírito Santo (2018). *Perfil da avicultura capixaba*. Recuperado de http://www.associacoes.org.br/images/PERFIL_AVICULTURA_CAPIXABA_2017_-_2018.pdf
- Berchieri, A. B., Jr., & Macari, M. (2000). *Doenças de aves*. Campinas, SP: Facta.
- Bilgili, S. F., & Hess, J. H. (2008). Miopatia peitoral profunda. Informativo traduzido do original Ross Tech 08/48, 2008. *Aviagen Brasil: Tecnologia*, 1(3), 1-6. Recuperado de <https://www.yumpu.com/pt/document/read/10089560/miopatia-peitoral-profunda-aviagen>
- Decreto nº 9.013, de 29 de março de 2017. Diário da república nº 129. Regulamenta a lei nº 1.2, de 18 de dezembro de 1950, e a lei nº 7.889, de 23 de novembro de 1989, que dispõe sobre a inspeção industrial e sanitária de produtos de origem animal. Recuperado de http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2017/decreto/d9013.htm
- Dias, M. C., Borgo, A., Martinelli, F., Castro, H. E. W., Jefferson, G., & Falçoni, F. M. de S. M. (2017). Principais causas e impacto econômico de condenações parciais de carcaças de frangos de corte em um matadouro frigorífico do sul do Espírito Santo. *Revista Dimensão Acadêmica*, 2(1), 20-34. doi: Recuperado de <https://multivix.edu.br/wp-content/uploads/2018/09/revista-dimensao-academica-v02-n01-artigo-02.pdf>
- Ebling, P. D., & Basurco, V. (2016). Análise das perdas econômicas oriundas da condenação de carcaças nos principais estados brasileiros produtores de frangos de corte. *Revista Ciências Agroveterinárias*

- e *Alimento*, 1(1), 1-11. Recuperado de <http://revistas.faiacademias.edu.br/index.php/cava/article/view/193>
- Ferreira, T. Z., Sesterhenn, R., & Kindlein, L. (2012). Perdas econômicas das principais causas de condenações de carcaças de frangos de corte em matadouros-frigoríficos sob inspeção federal no Rio Grande do Sul. *Acta Scientiae Veterinariae*, 40(1), p. 1-6. Recuperado de <http://www.ufrgs.br/actavet/40-1/PUB%01021.pdf>
- Flemming, J. S., Janzen, S. A., & Endo, M. A. (1999). Rendimento de carcaças em linhagens comerciais de frangos de corte. *Archives Veterinary Science*, 4(1), p. 61-63. doi: 10.5380/avs.v4i1.3781 Recuperado de <https://revistas.ufpr.br/veterinary/article/view/3781/3022>
- Goscinski, F. (2016). Análise dos índices de condenação de carcaças de frango em abatedouro da região norte paranaense. *Higiene Alimentar*, 30(260/261), p. 73-77. Recuperado de <http://docs.bvsalud.org/biblioref/11/2721/260-261-sitecompressed-73-77.pdf>
- Gundim, L. F., Rodrigues, E. A., Blanca, W. T., Coletto, A. F., & Medeiros, A. (2015). Causas de condenações de frangos de corte relacionadas a manejo e ambiência. *Revista Enciclopédia Biosfera*, 11(21), 515. Recuperado de <https://www.conhecer.org.br/enciclop/2015b/agrarias/Causas%20de%20condenacao%20de%20frangos.pdf>
- Hoving-Bolink, A. H., Kranen, R. W., Klont, R. E., Gerritsen, C. L. M., & Greef, K. H. (2000). Fibre area and capillary supply in broiler breast muscle in relation to productivity and ascites. *Meat Science*, 56(4), 397-402. doi: 10.1016/S0309-1740(00)00071-1 Retrieved from <https://pubmed.ncbi.nlm.nih.gov/22062170/#:~:text=Normally%20capillary%20densities%20decrease%20in,had%20a%20lower%20capillary%20density>
- Instituto Brasileiro de Geografia e Estatística (2017). *Censo agropecuário 2017*. Recuperado de https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/pecuaria.html?localidade=0&tema=76579
- Joiner, K. S., Hamlin, G. A., Lien, A. R., & Bilgili, S. F. (2014). Evaluation of capillary and myofiber density in the pectoralis major muscles of rapidly growing, high-yield broiler chickens during increased heat stress. *Avian Diseases*, 58(3), 377-382. doi: 10.1637/10733-112513-Reg.1 Retrieved from <https://pubmed.ncbi.nlm.nih.gov/25518431/>
- Kettlewell, P. J., & Turner, M. J. B. (1985). A review of broiler chicken catching and transport systems. *Journal of Agricultural Engineering Research*, 31(2), 93-114. doi: 10.1016/0021-8634(85)90064-2 Retrieved from <https://www.sciencedirect.com/science/article/abs/pii/0021863485900642>
- Kotler, D. P. (2000) Cachexia. *Annals of Internal Medicine*, 133(1), 622-634. doi: 10.7326/0003-4819-133-8-200010170-00015 Retrieved from <https://www.acpjournals.org/doi/10.7326/0003-4819-133-8-200010170-00015>
- Langer, R. O. (2007). *Efeito do transporte na incidência de PSE (Pale, Soft, Exudative) e análogo ao DFD (Dark, Firm, Dry) em filés de frangos*. Dissertação de mestrado, Universidade Estadual de Londrina, Londrina, PR, Brasil. Recuperado de <http://www.bibliotecadigital.uel.br/document/?view=vtls000123367>

- Leandro, N. S. M., Rocha, P. T., Stringhini, J. H., & Fortes, R. M. (2001). *Efeito do tipo de captura dos frangos de corte sobre a qualidade da carcaça*. Recuperado de <http://200.137.217.156/bitstream/ri/12371/5/Artigo%20-%20Nadja%20Susana%20Mogyca%20Lenandro%20-%202001.pdf>
- Lei n. 1.283, de 19 de dezembro de 1950*. Dispõe sobre a inspeção industrial e sanitária dos produtos de origem animal. Recuperado de http://www.planalto.gov.br/ccivil_03/LEIS/L1283.htm
- Lei n. 7.889, de 23 de novembro de 1989*. Dispõe sobre a inspeção sanitária e industrial dos produtos de origem animal, e dá outras providências. Recuperado de http://www.planalto.gov.br/ccivil_03/LEIS/L7889.htm
- Maschio, M. M., & Raszl, S. M. (2012). Impacto financeiro das condenações post-mortem parciais e totais em uma empresa de abate de frango. *Atualidades Tecnológicas para Competitividade Industrial (e-tech)*, 1(1), 26-38. doi: 10.18624/E-TECH.V010.208 Recuperado de <https://pdfs.semanticscholar.org/dfec/6912faa02b9beb73892d801c6c73bcd3daf.pdf>
- Mendes, A. A., & Komiyama, C. M. (2011). Estratégias de manejo de frangos de corte visando qualidade de carcaça e carne. *Revista Brasileira de Zootecnia*, 40(1), 352-357. Recuperado de <http://hdl.handle.net/11449/141114>
- Moreira, J., Mendes, A. A., Garcia, E. A., Oliveira, R. P. D., Garcia, R. G., & Almeida, I. C. L. D. (2003). Avaliação de desempenho, rendimento de carcaça e qualidade da carne do peito em frangos de linhagens de conformação versus convencionais. *Revista Brasileira de Zootecnia*, 32(6), 1663-1673. doi: 10.1590/S1516-35982003000700016 Recuperado de https://www.scielo.br/scielo.php?pid=S1516-35982003000700016&script=sci_abstract&tlng=pt
- Oliveira, A. A., Andrade, M. A., Armendaris, P. M., & Bueno, P. H. S. (2016). Principais causas de condenação ao abate de aves em matadouros frigoríficos registrados no serviço brasileiro de inspeção federal entre 2006 e 2011. *Revista Ciência Animal Brasileira*, 17(1), 79-89. 10.1590/1089-6891v17i123020 Recuperado de <https://www.scielo.br/pdf/cab/v17n1/1809-6891-cab-17-01-0079.pdf>
- Paschoal, E. C., Otutumi, L. K., & Silveira, A. P. (2012). Principais causas de condenações no abate de frangos de corte de um abatedouro localizado na região Noroeste do Paraná, Brasil. *Arquivos de Ciências Veterinárias e Zoologia da UNIPAR*, 15(2), 93-97. doi: 10.25110/arqvet.v15i2.2012.4209 Recuperado de <https://revistas.unipar.br/index.php/veterinaria/article/view/4209/2618>
- Portaria nº 210, de 10 de novembro de 1998*. Diário da república – seção I. Ministério da Agricultura, Pecuária e Abastecimento. Aprovar o regulamento técnico de Inspeção Tecnológica e Higiênico-Sanitária de Carnes de Aves. Recuperado de <http://extranet.agricultura.gov.br/sislegis-consulta/consultarLegislacao.do?operacao=visualizar&id=1129>
- Rossi, G. A. (2020). *Achados patológicos em abates de aves*. Recuperado de <http://qualiflix.com.br/video-interna.php?id=192927955>

- Saif, Y. M. (2003). *Diseases of poultry* (13th ed.). Ames: Iowa State University Press.
- Santiago, H. L. (2001). Impact of genetic selection on skeletal muscle in meat-type poultry. *Proceeding of the Virginia Polytechnic Institute e State University Graduate Seminar*, Blackburg, Virginia, Estados Unidos. Retrieved from <http://academic.uprm.edu/hsantiago/Impact%20of%20Genetic%20Selection%20on%20Skeletal%20Muscle%20In%20Meat%20Type%20Poultry.pdf>
- Santos, A. L. dos, Sakomura, N. K., Freitas, E. R., Fortes, C. M. L. S., Carrilho, E. N. V. M., & Fernandes, J. B. K (2005). Estudo de crescimento, desempenho, rendimento de carcaça e qualidade de carne de três linhagens de frango de corte. *Revista Brasileira de Zootecnia*, 34(5), 589-1598. doi: 10.1590/S1516-35982005000500020 Recuperado de https://www.scielo.br/scielo.php?pid=S1516-35982005000500020&script=sci_abstract&tlng=pt
- Tinôco, I. D. F. (2001). Avicultura industrial: novos conceitos de materiais, concepções e técnicas construtivas disponíveis para galpões avícolas brasileiros. *Brazilian Journal of Poultry Science*, 3(1), 1-26. doi: 10.1590/S1516-635X2001000100001 Recuperado de https://www.scielo.br/scielo.php?pid=S1516-635X2001000100001&script=sci_arttext&tlng=pt

