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MICROBIOLOGICAL QUALITY OF *IN NATURA* SLAUGHTERHOUSE BEEF FROM THE CENTRAL REGION OF RONDÔNIA

QUALIDADE MICROBIOLÓGICA DA CARNE BOVINA IN NATURA DE ABATEDOURO-FRIGORÍFICO DA REGIÃO CENTRAL DE RONDÔNIA

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RESUMO: O Brasil é um importante fornecedor de alimentos para os mercados internacionais, com papel de referência sobre a produção e exportação de carne bovina. A carne bovina *in natura* sem os devidos cuidados higiênico-sanitários pode oferecer riscos à saúde do consumidor, porque se caracteriza como substrato para multiplicação de microrganismos que podem causar surtos de infecções alimentares, proporcionando grandes prejuízos econômicos. O objetivo deste trabalho de levantamento de dados foi realizar análise microbiológica da carne *in natura* de bovinos abatidos em um abatedouro-frigorífico sob inspeção federal localizado no município de Ji-Paraná, estado de Rondônia. Com ênfase nos seguintes gêneros: *Escherichia coli*, *Salmonella spp*. e *Staphylococcus* coagulase positiva. Os dados foram disponibilizados pelo Serviço Inspeção Federal (SIF). Os resultados das análises microbiológicas para *Escherichia coli* do período de janeiro de 2017 a junho de 2018 demostraram que não houve nenhuma amostra acima do limite máximo de detecção (LMD). As análises de *Salmonella spp.* em carcaças resfriadas realizadas durante o ciclo anual, demonstraram que se manteve dentro dos padrões microbiológicos aceitáveis. No levantamento de dados de *Staphylococcus* coagulase positiva obteve-se resultados de 100% das análises dentro dos padrões recomendados. Os resultados foram satisfatórios em comparação com trabalhos pesquisados na literatura, observando assim um comprometimento do abatedouro-frigorífico com a segurança alimentar e saúde pública de seus consumidores, por meio dos planos de autocontrole e boas práticas de fabricação.

Palavras-Chave: *Escherichia coli*; Serviço de Inspeção Federal; *Salmonela* spp.; saúde pública; *Staphylococcus* coagulase positiva.

ABSTRACT: Brazil is an important supplier of food to international markets, with a reference role on the production and export of beef. Beef *in natura* without proper hygienic-sanitary care can pose risks to the consumers health, because it is characterized as a substrate for the multiplication of microorganisms that can cause outbreaks of food infections, providing great economic losses. The purpose of this data collection work was to perform a microbiological analysis of fresh meat from cattle slaughtered in a slaughterhouse under federal inspection

located in the municipality of Ji-Paraná, state of Rondônia. With an emphasis on the following genera: *Escherichia coli*, *Salmonella* spp. and coagulase-positive *Staphylococcus*. The data were made available by the Federal Inspection Service (SIF). The results of the microbiological analyzes for Escherichia coli, from January 2017 to June 2018, showed that there was no sample above the maximum limit of detection (LMD). Analyzes of *Salmonella* spp. in chilled carcasses, carried out during the annual cycle, demonstrated that it remained within the acceptable microbiological standards. In the data collection of coagulase-positive *Staphylococcus*, results of 100 % of the analyzes were obtained within the recommended standards. The results were satisfactory in comparison with other research in the literature, thus observing a commitment of the slaughterhouse with the food safety and public health of its consumers, through self-control plans and good manufacturing practices.

Keywords: *Escherichia coli;* Federal Inspection Service; public health; coagulase-positive *Staphylococcus*; *Salmonela* spp.

INTRODUCTION

Brazil has reached excellent levels, in recent years, in the domestic market and in exports, being an activity of economic potential for the country (SCHIERHORN et al., 2016). However, importing countries have been inspecting and demanding a higher quality product with regard to safety (CAMARGO et al., 2019), forcing producers and slaughterhouses to meet these requirements.

With regard to chilled beef, requirements include the implementation of Good Manufacturing Practices (GMP) and the Hazard Analysis and Critical Control Point (HACCP) system, the principles of which are currently required by importers such as the United States of America and the European Union (LIMA JUNIOR et al., 2011; SCHIERHORN et al., 2016). The competitiveness and survival of the beef industry on the international market are directly related to its ability to manage quality and ensure product safety for its respective consumers (RODRIGUES; NANTES, 2010; RUVIARO et al., 2014).

However, in addition to favorable climatic conditions, the state of Rondônia has been considered free of foot-and-mouth disease since 2003, thanks to the efficiency of vaccination campaigns. In view of this, Rondônia has several slaughterhouses under the Federal Inspection Service (SIF), a large part of them qualified for export (ALVES, 2018). However, fresh beef can offer risks to the health of the consumer, as it is characterized as an excellent substrate for the multiplication of numerous microorganisms that, when find appropriate conditions to develop, cause deterioration and consequent organoleptic changes and reduced product life providing large economic losses (LIMA JUNIOR et al., 2011). In addition, these microorganisms can promote outbreaks of foodborne infections and infections, compromising the consumers health (FERREIRA, 2012).

Microbiological quality is mainly associated with the quantity and type of microorganism present, the availability to multiply, and hygiene (handling, environment, utensils and surfaces) (HOFFMANN, 2001; MATOS et al., 2013). Beef due to its intrinsic factors (water activity, nutritional composition and pH) is highly favorable to microbial development (LERSY et al., 2016).

In this context, this study aimed to compile data regarding the results of microbiological analyzes carried out on chilled bovine carcasses in a slaughterhouse under federal inspection in the central region of the state of Rondônia, more specifically in the municipality of Ji-Paraná, with emphasis on the following genera: *Escherichia coli* spp., *Salmonella* spp. and coagulase-positive *Staphylococcus*. For this purpose, data made available by the Federal Inspection Service (SIF), stored in the SIF Management Information System

(SIGSIF) were used. The analyzes were carried out by the National Agricultural Laboratory (LANAGRO-SP) and the Food Analysis Laboratory of the State of Mato Grosso (LAPOA-MT), between January 2017 and June 2018.

MATERIAL AND METHODS

The research was carried out by means of data collection of official results of microbiological analyzes of slaughterhouse of cattle under Federal Inspection (SIF) of the municipality of Ji-Paraná, state of Rondônia. It is worth mentioning that the data from the Official Analysis Certificates (COA) were made available by the SIF.

The data used came from the SIF for the sanitary control of the animal product, which is carried out by the National Agricultural Laboratory (LANAGRO-SP) and the Food Analysis Laboratory of the state of Mato Grosso (LAPOA-MT). The results are from April 2016 to June 2018, with an emphasis on the following genera of microorganisms: *Escherichia coli*, *Salmonella* spp. and coagulase-positive *Staphyloccocus* in chilled meat.

The collected samples were defined by a statistical survey carried out by the Animal Products Inspection Department (DIPOA), and were communicated to official veterinarians. The collections were carried out during the handling of the food in the deboning room before the final packaging and its storage, carried out by means of chilled carcasses.

The data collection was carried out for microorganisms on the surface of bovine carcasses after 24 hours of cooling. The material was collected from every 300 carcasses as defined by Circular No. 245/1996/DCI/DIPOA. The refrigerated samples were identified with a label and with a microbiological research request report and with the use of the seal to maintain the integrity of the sample and documentary traceability, as well as the quarantine of the samples for possible counter-proof.

For the control, 25g samples were collected from three different points of the refrigerated carcasses. The collection points were in the void, chest and rump regions. The samples were stored in isothermal boxes at a temperature of 4ºC and transported to laboratories accredited by MAPA.

The aforementioned accredited laboratories followed the guidelines of Normative Instruction No. 62, of August 26, 2003 (BRASIL, 2006), in which it officializes the Official Analytical Methods for Microbiological Analysis for Control of Products of Animal Origin and Water. The samples were analyzed using the AOAC 998.08 - *E. coli* Petrifilm ™ methodology described in the Official Methods of Analysis of AOAC International (HORWITZ; LATIMER, 2005), validated by MAPA (BRASIL, 2005). For the interpretation of the results, MAPA uses as reference the Resolution RDC Nº 12, of January 2001 of the National Health Surveillance Agency (ANVISA) (BRASIL, 2001).

RESULTS

Escherichia coli

For *Escherichia coli*, the data collected are expressed in two tables according to the respective year of analysis - 2017 (Table 1) and 2018 (Table 2). The results of the counts were expressed in Colony Forming Units (CFU g^{-1}), thus establishing the maximum detection limit (MDL) of 0.990 CFU g^{-1}. Values below this limit were considered negative results and represented as <1.0 CFU g^{-1}.

Table 1. Analyzes performed for *Escherichia coli* during 2017, between the months of January and December, considering the maximum detection limit (MDL) of 0.890 CFU g^{-1}.

Month	Number of total analyses	Results according to the standard	Results not in accordance with the standard	<1.0 CFU g^{-1}	1.0 a 5.0 CFU g^{-1}	> 5.0 CFU g^{-1}
January	20	20	0	20	0	0
February	18	18	0	18	0	0
March	21	21	0	21	0	0
April	20	20	0	20	0	0
May	17	17	0	17	0	0
June	----------	----------	----------	----------	----------	----------
		--		---	---	-
July	20	20	0	20	0	0
August	----------	----------	----------	----------	----------	----------
		--		---	---	-
September	42	42	0	42	0	0
October	24	24	0	24	0	0
November	----------	----------	----------	----------	----------	----------
		--		---	---	-
December	17	17	0	17	0	0
Total	199	199	0	199	0	0
%	100	100	0	100	0	0

Table 2. Results of the analyzes performed for *Escherichia coli* during 2018, between the months of January and June, considering the maximum limit of detection (MDL) of 0.890 CFU g^{-1}.

Month	Number of total analyses	Results according to the standard	Results not in accordance with the standard	<1.0 CFU g^{-1}	1.0 a 5.0 CFU g^{-1}	> 5.0 CFU g^{-1}
January	14	14	0	14	0	0
February	21	21	0	21	0	0
March	16	16	0	16	0	0
April	----------	----------	----------	----------	----------	----------
	-	--			--	--
May	22	22	0	22	0	0
June	18	18	0	18	0	0
Total	91	91	0	91	0	0
%	100	100	0	100	0	0

***Salmonella* spp.**

MAPA, through Circular No. 665 CGPE/DIPOA, of September 19, 2006 (BRASIL, 2006) establishes an annual collection cycle of 82 samples for microbiological analysis to detect *Salmonella* spp. The samples were collected after 24 hours of cooling. The results are expressed in two tables according to their respective year - 2017 (Table 3) and 2018 (Table 4). The data

collection of the specific analyzes for the Salmonella genus occurred during the period from January 2017 to June 2018.

With regard to analyzes for the Salmonella genus, the present study clarified the existence of strict control with its self-control plans and good manufacturing practices by the slaughterhouse, thus meeting the microbiological standards required by current legislation (Table 3 and 4).

Table 3. Results of the analyzes carried out for *Salmonella* spp. during 2017, between the months of January and December.

Month	Number of total analyses	Results according to the standard	Results not in accordance with the standard
January	8	8	0
February	9	9	0
March	10	10	0
April	8	8	0
May	11	11	0
June	----------	----------	----------
July	8	8	0
August	----------	----------	----------
September	9	9	0
October	10	10	0
November	----------	----------	----------
December	9	9	0
Total	82	82	0
%	100	100	0

Table 4. Results of the analyzes carried out for *Salmonella* spp. during 2018, between the months of January and June.

Month	Number of total analyses	Results according to the standard	Results not in accordance with the standard
January	7	7	0
February	9	9	0
March	7	7	0
April	----------	----------	----------
May	10	10	0
June	8	8	0
Total	41	41	0
%	100	100	0

Coagulase-positive *Staphyloccocus*

Data collection of specific analyzes for coagulase-positive *Staphyloccocus* occurred during 2017, from January to December. The results of the research are shown in Table 5. For interpretation of the results, Resolution RDC No. 12, of January 2001 of the National Health Surveillance Agency (ANVISA) (BRASIL, 2001) was used as a reference.

Table 5. Analyzes performed for coagulase-positive *Staphyloccocus* during 2017, between the months of January and December.

Month	Number of total analyses	Results according to the standard	Results not in accordance with the standard	<1.0 CFU g^{-1}	1.0 a 5.0 CFU g^{-1}	> 5.0 CFU g^{-1}
January	13	13	0	13	0	0
February	18	18	0	18	0	0
March	20	20	0	20	0	0
April	18	18	0	18	0	0
May	17	17	0	17	0	0
June	----------	----------	----------	----------	----------	----------
	--	--		--	--	--
July	15	15	0	15	0	0
August	----------	----------	----------	----------	----------	----------
	--	--		--	--	--
September	29	29	0	29	0	0
October	24	24	0	24	0	0
November	----------	----------	----------	----------	----------	----------
	--	--		--	--	--
December	23	23	0	23	0	0
Total	177	177	0	177	0	0
%	100	100	0	100	0	0

DISCUSSION

According to Santos (2014), in his survey of data collection of microbiological analysis in a slaughterhouse under federal inspection of the state of Rondônia, there was a 98.48 % absence for *Salmonella* spp. Result equivalent to that presented in the present research, with a percentage of 100 % of absence in the analyzed samples. The analyzes showed that the slaughterhouse remained within acceptable microbiological standards.

According to Resolution RDC No. 12, of January 2001 of the National Health Surveillance Agency (ANVISA) (BRASIL, 2001), it is recommended the total absence of *Salmonella* spp. in 25g of the analyzed product. This demonstrates that the samples were obtained under adequate hygiene conditions, maintaining that good manufacturing practices, with quality programs applied satisfactorily.

Corroborating with the data from the present study, Chagas et al. (2017) conducted a study in 8 slaughterhouses located in the state of Pará, and found the absence of *Salmonella* sp. in the samples analyzed, thus having a percentage of 100 % absence in their survey due to the commitment to hygienic-sanitary care. On the other hand, data from a research performed by Silva et al. (2014) showed a percentage of 0.075 and 3.3 % for the presence of the genus Salmonella. Although, Silva (2012) in his research involved 21 positive samples for *Salmonela* sp., 9 were from corral feces, 7 from ruminal fluid and 5 from rectal feces, which represents a prevalence of *Samonella* sp. in the gastrointestinal system.

According to Silva et al. (2014), *Salmonella* sp. can contaminate meat production from poorly handled animals. In addition, flaws in self-control plans and good manufacturing practices contribute to several points of contamination. Rodrigues (2019) stated that the microbial load present in the animal's leather can exceed 109 CFU per cm^2, and this microbiota

can contaminate the carcass in the initial stages of slaughter, facilitating the introduction of contaminants into the slaughter and processing environment, thus leading to contamination of the carcass, highlighting the importance of hygiene of the ante-mortem animal, thus avoiding further contamination.

Similar results to the present study were found by Santos (2014) and Silva et al. (2014), who demonstrated a percentage of 96.13 and 99.87 %, respectively, of samples that were submitted to the analysis of *Escherichia coli* and maintained according to the standards required by the inspection bodies. Unlike the study by Silva (2019), which attributed the presence of coliforms and *E. coli* to inadequate hygienic-sanitary practices in obtaining meat, the good results found in the present study allow us to admit that the self-control plans and good manufacturing practices were properly applied throughout the slaughter line.

Pinheiro et al. (2016) carried out a data survey in a slaughterhouse using 675 chilled carcasses, obtaining a result of 89.6 % of samples classified below the maximum limit of detection (MLD), data different when comparing with the results found by Casagrande et al. (2013), that observed an occurrence of *Escherichia coli* in 16.7 % in their research. These authors stated that such contamination is due to several factors, among them, the use of intensive farming system, because they are more susceptible the accumulation of large amounts of faecal matter on the skin due to the closer proximity of the cattle to each other, compared to the extensive regime.

According to Tergney and Bolton (2006), the primary source of fecal contamination of bovine carcasses within the post-slaughter operation is skinning. However, Zweifel and Stephan (2003) clarified that the quantification of the population of viable microorganisms on the surfaces of the carcasses is commonly used to provide data that indicate the degree of hygienic-sanitary care during slaughter operations, particularly in skinning and evisceration. According to Fontoura et al. (2010), only when the number of viable microorganisms on the surface of bovine carcasses exceeds 105 per cm^2, it can be said that the slaughter occurred in poor hygiene conditions.

According to Rosec et al. (1997), there are many strains of coagulase-negative *Staphylococcus* that can produce enterotoxins for humans. Similar prevalence to this study was found by Fontoura (2010), where he obtained a percentage of 100 % absence for coagulase-positive *Staphylococcus*. In the data collection of the present research, 177 samples were analyzed, in the year 2017, for coagulase-positive *Staphylococcus*, and results were obtained in general average <1.0 CFU g^{-1}. Therefore, there was no detection of the microorganism in the samples, that is, 100 % of the results followed the standards established by current legislation. This low count points to good indicators against contamination since the slaughter process to the conditioning of these meat products demonstrate a correct use of self-control plans

Unlike the present study, a study by Luz et al. (2017) in bovine slaughterhouses under municipal inspection located in the state of Piauí (Brazil), obtained a percentage of 84 % of positive analyzes for *Staphylococcus aureus* considered to be coagulase-positive. The same study reports the precariousness in the cleaning of equipment and utensils and the lack of good practices in food handling. However, according to Almeida et al. (1995) and Alves (2006), the main source of contamination is through the hands of the employees and contaminated utensils, representing a great epidemiological importance. According to Germano (2008) and Trabilsi and Toledo (1999) the genus Staphylococcus is a commensal microorganism in humans, which can inhabit the skin, the upper respiratory tract and is very present in the digestive system.

CONCLUSIONS

The data collection of microbiological analyzes of beef chilled in a slaughterhouse in Ji-Paraná-RO showed results for Escherichia coli from January 2017 to June 2018 and demonstrated that there was no sample above the maximum detection limit (MDL). Results from analyzes of *Salmonella* spp. in chilled carcasses, carried out during the annual cycle, demonstrated that it remained within the acceptable microbiological standards. Data collection of coagulase-positive Staphylococcus showed that 100 % of the results of the analyzes were obtained within the standards of the current legislation.

In view of the research carried out, it can be understood that the results were satisfactory, thus observing a commitment of the slaughterhouse with the food safety and public health of its consumers, through self-control plans and good manufacturing practices.

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