

Contamination of chickens by *Salmonella* spp., in Brazil: an important public health problem

Contaminação de frangos comercializados no Brasil por *Salmonella* spp.: um importante problema de saúde pública
Contaminación de pollos comercializados en Brasil por *Salmonella* spp.: un importante problema de salud pública

Francisco Patrício de ANDRADE JÚNIOR¹

Brenda Tamires de Medeiros LIMA²

Thiago Willame Barbosa ALVES²

Bren Carla de Medeiros LIMA³

Laísa Vilar CORDEIRO⁴

Vanessa Santos de Arruda BARBOSA⁵

Edeltrudes de Oliveira LIMA⁶

¹Master's Degree, Post-Graduate Program in Natural and Synthetic Bioactive Products, Federal University of Paraíba, João Pessoa – PB, Brazil

²Graduated on the Department of Pharmacy, Center of Education and Health, Federal University of Campina Grande, Cuité – PB, Brazil

³Graduating in Food Engineering, Agro-Food Science and Technology Center, Federal University of Campina Grande, Pombal – PB, Brazil

⁴Doctor student, Post-Graduate Program in Natural and Synthetic Bioactive Products, Federal University of Paraíba, João Pessoa – PB, Brazil

⁵Center of Education and Health, Federal University of Campina Grande, Cuité - PB, Brazil

⁶Prof. Dr. and Advisor, Postgraduate Program in Natural and Synthetic Bioactive Products, Federal University of Paraíba, João Pessoa-PB, Brazil

Abstract

Introduction: Bacteria of the genus *Salmonella* are important pathogens involved in the contamination of various foods, such as chickens, and may cause food poisoning. Aim: The present study aimed to review the literature on the prevalence of chickens contaminated with *Salmonella* spp., which are commercialized in different Brazilian states. Material and methods: This was a literary review. The absolute frequency and the total percentage of contaminated samples was calculated and the Qui-square statistical test was applied, considering statistically significant $p < 0.05$. Results: 616 publications were retrieved, but only 10 articles were included to compose the results. The cataloged studies were carried out in 14 different Brazilian states, and it was observed that of 5,030 chicken samples analyzed, the mean prevalence of samples contaminated with *Salmonella* was 7.3% ($n = 365$). In addition, the prevalence of samples in the different studies ranged from 2.5% to 44.6%. The most prevalent serotype was *S. Enteritidis* (28.7%) and a statistically significant association between the type of raw material for commercialization and the result of the chicken samples microbiological analysis was observed ($p < 0.001$), where the carcasses represented 90.1% of the contaminated samples. Conclusion: Thus, the data presented in this study can serve as subsidy for the development of necessary, political or legislative, measures that allow a better control of commercialized chickens in Brazil.

Descriptors: Salmonella; Foodborne Diseases; Epidemiology.

Resumo

Introdução: Bactérias do gênero *Salmonella* são importantes patógenos envolvidos na contaminação de diversos alimentos, a exemplo de frangos, podendo ocasionar em intoxicação alimentar. Objetivo: O presente estudo teve como objetivo fazer uma revisão de literatura acerca da prevalência de frangos contaminados por *Salmonella* spp., comercializados em diferentes estados brasileiros. Material e métodos: Tratou-se de uma revisão literária. Analisou-se a frequência absoluta e calculou-se o percentual total de amostras contaminadas; o teste Qui-Quadrado foi aplicado, considerando $p < 0,05$ estatisticamente significativo. Resultados: Na revisão de literatura houve a recuperação de 616 publicações, porém somente 10 artigos foram incluídos para compor os resultados. Os estudos catalogados foram realizados em 14 estados distintos, e foi observado que de 5.030 amostras de frango analisadas, a prevalência média de amostras contaminadas por *Salmonella* foi de 7,3% ($n=365$). Além disso, a prevalência de amostras nos diferentes estudos variou entre 2,5% a 44,6%. O sorotipo mais prevalente foi *S. Enteritidis* (28,7%) e associação estatisticamente significativa, entre o tipo de matéria prima para comercialização e o resultado da análise microbiológica das amostras de frango foi observada ($p < 0,001$), em que as carcaças representaram 90,1% das amostras contaminadas. Conclusão: Assim, os dados apresentados neste estudo podem servir de subsídio para o desenvolvimento de medidas cabíveis, sejam elas políticas ou legislativas, que permitam maior fiscalização dos frangos comercializados no Brasil.

Descritores: Salmonella; Doenças Transmitidas por Alimentos; Epidemiologia.

Resumen

Introducción: las bacterias del género *Salmonella* son patógenos importantes involucrados en la contaminación de varios alimentos, como los pollos, y pueden causar intoxicación alimentaria. Objetivo: El objetivo de este estudio fue revisar la literatura sobre la prevalencia de *Salmonella* spp. en pollos contaminados comercializados en diferentes estados brasileños. Material y métodos: se trata de una revisión literaria. Se analizó la frecuencia absoluta y se calculó el porcentaje total de muestras contaminadas; Se aplicó la prueba de chi-cuadrado, considerando $p < 0.05$ estadísticamente significativo. Resultados: En la revisión de la literatura recuperó 616 publicaciones, pero solo se incluyeron 10 artículos para componer los resultados. Los estudios catalogados se realizaron en 14 estados diferentes, y se observó que de 5.030 muestras de pollo analizadas, la prevalencia promedio de muestras contaminadas con *Salmonella* fue del 7.3% ($n=365$). Además, la prevalencia de muestras en diferentes estudios varió de 2.5% a 44.6%. El serotipo más prevalente fue *S. Enteritidis* (28.7%) y se observó una asociación estadísticamente significativa entre el tipo de materia-prima para comercialización y el resultado del análisis microbiológico de muestras de pollo ($p < 0.001$), donde los cadáveres representaron 90,1% de muestras contaminadas. Conclusión: Por lo tanto, los datos presentados en este estudio pueden usarse como un subsidio para el desarrollo de medidas apropiadas, ya sean políticas o legislativas, que permitan una mayor supervisión de los pollos de engorde comercializados en Brasil.

Descriptor: Salmonella; Enfermedades Transmitidas por los Alimentos; Epidemiología.

INTRODUCTION

The poultry industry is responsible for the supply of meats and products derived from poultry, with an annual production of over 106 million tons and presenting as one of the main difficulties the control of microorganisms in their products, such as chicken meat¹⁻³.

In the nutritional aspect, chicken meat is an excellent source of protein, B complex, vitamins and minerals. However, due to its intrinsic characteristics

such as high nutrient content, high water activity, pH near neutrality and meat storage sites, this favors the growth of microorganisms such as bacteria of the genus *Salmonella*⁴.

Salmonella genus is characterized by rod-shaped bacteria, belonging to the family Enterobacteriaceae, mobile, facultative anaerobic and non-spore-producing. In addition, these microorganisms are extremely important for public health

since they are used worldwide for the determination of food microbiological standards^{1,5,6}.

In Brazil, the prevalence data and microbial ecology of *Salmonella* spp., in the chicken commercialization process are scattered and inconclusive. However, these bacteria are among the main responsible for outbreaks of foodborne diseases, which can lead to bacteremia, gastroenteritis or even enteric fever^{5,7}.

Thus, the present study aimed to review the literature on the prevalence of chickens contaminated with *Salmonella* spp., which are commercialized in different Brazilian states.

MATERIAL AND METHOD

○ Study Design

It was a literary review allowing, therefore, the synthesis of certain information taken from previously published studies that are pertinent to the theme.

○ Inclusion and exclusion criteria

Were included studies that investigated the presence of *Salmonella* spp., in chickens that were available for commercialization in different Brazilian states and published between the years of 2008 and 2018. Researches conducted in other countries or published outside the delimited period were excluded from the study.

○ Information sources

The articles were retrieved from the databases: Lilacs (Latin American and Caribbean Center on Health Sciences), Scielo (Scientific Electronic Library Online) and PubMed. Data collection occurred between November 2018 and June 2019. The last update occurred on June 20, 2019.

○ Search strategy

The search strategy used to find articles in the databases was based on the use of the following descriptors and keywords: "Salmonella", "Chicken" and "Brazil".

○ Data extraction

The following variables were extracted: author(s), year, Brazilian federative unit, raw material type, total of samples analyzed, total samples contaminated by *Salmonella* and *Salmonella* serotypes found.

○ Statistical analysis

The absolute number of the investigated samples was analyzed and the percentage of samples contaminated by *Salmonella* was determined for each of the studies. In addition, the average prevalence of chickens contaminated by bacteria of this genus and the serotypes percentage found was calculated. The statistical association was performed through the Statistical Package for Social Sciences (SPSS) version 13.0, using the Qui-square statistical test, where it was considered statistically significant when

$p < 0.05$ for rejection of null hypotheses.

RESULTS AND DISCUSSION

In literature review, 616 publications were retrieved, but only 10 articles were included to compose the results. The table below shows the prevalence of *Salmonella* spp., in chickens commercialized in different Brazilian states (Table 1).

Table 1. Prevalence of *Salmonella* in chickens commercialized in different Brazilian states in studies published between the years 2008-2018

Author and year	Federative unit	Type of raw material	Total of analyzed samples	Total samples contaminated with <i>Salmonella</i>
Borsoi et al. 2010 ⁸	Rio Grande do Sul	Carcasses	180	22 (12,2%)
Cardoso et al. 2009 ⁹	São Paulo	Meat cuts (chicken breast)	112	36 (32,1%)
Cunha Neto et al., 2018 ¹⁰	Mato Grosso	Carcasses	850	31 (3,6%).
Duarte et al. 2009 ¹¹	Brazilian Northeast	Carcasses	260	25 (9,6%)
Medeiros et al. 2011 ¹²	Amapá, Ceará, Rio Grande do Norte, Alagoas, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Goiás, Distrito Federal, Mato Grosso do Sul, Paraná, Santa Catarina, Rio Grande do Sul.	Carcasses	2679	73 (2,7%)
Menezes et al. 2018 ¹³	Minas Gerais	Carcasses	240	22 (9,2%)
Moreira et al. 2008 ¹⁴	Goiás	Carcasses	363	52 (14,3%)
Possebom et al. 2012 ¹⁵	São Paulo	Carcasses	130	58 (44,6%)
Tessari et al. 2008 ¹⁶	São Paulo	Carcasses	116	3 (2,5%)
Yamatogi et al. 2011 ¹⁷	São Paulo	Carcasses	100	43 (43%)
Total			5,030	365 (7,3%)

Source: Research Data, 2019

The cataloged studies were carried out in 14 different states, where the average prevalence of *Salmonella* contamination was 7,3% (n = 365) of the 5,030 chicken samples analyzed. In addition, the prevalence of contaminated samples in the different studies ranged from 2.5% to 44.6%.

Similar results were observed in the cities of the states of Uttarakhand and Uttar Pradesh, India. In several chicken samples for commercialization, the prevalence of this bacterium in the chicken meat samples was 14.9% (28/188), being significantly higher when compared to samples of chicken feces (7,0%, 15/214) and environmental (7.9%, 27/340) with a value of $p < 0.01$ [18]. The result of this study is similar to that of Harb et al.¹⁹ carried out in Thi-Qar, southeastern Iraq, where 11.5% of a total of 400 frozen chicken carcasses were contaminated with *Salmonella*. In Singapore, among the 270 chicken meat samples collected for analysis, 49 were contaminated with *Salmonella*, resulting in a prevalence of 18.1%²⁰.

Differently, in Malaysia, higher prevalences were observed. It was noted that of the 35 chicken carcasses analyzed, 48% were contaminated by *Salmonella*.²¹ In China, a 12-month study was

conducted between 2011 and 2012, in which 1595 freshly slaughtered, chilled and frozen chicken carcasses were collected from supermarkets in various provinces. From the analyzes, it was found that 41.6% of the samples were contaminated by *Salmonella*²².

Smaller prevalences, when compared with the average prevalence found in our study, were observed in Estonia, where a survey conducted between 2008 and 2013 revealed that most food products contaminated with *Salmonella* are those that do not receive heat treatment, including broiler meat (4%, 7/175) and chicken meat (2,2%, 11/496)²³. Table 2 shows the statistical association between the raw material and *Salmonella* contamination.

Table 2. Statistical association between the type of raw material for commercialization and the result of the microbiological analysis of the chicken samples

Raw material	Uncontaminated samples		Contaminated samples*		P
	n	%	n	%	
Meat cuts**	76	1.6	36	9.9	<0,001
Carcass	4,589	98.4	329	90.1	
Total	4,665	100	365	100	

* Positive samples for *Salmonella*; ** Chicken breast
 Source: Research data, 2019

It was observed a statistically significant association between the type of raw material for commercialization and the result of the microbiological analysis of the chicken samples, in which the predominance of contaminated carcasses (90.1%) was evidenced. That result is understandable since, even before the marketing stage, the chickens may already be contaminated.

In addition, it has been elucidated that this bacteria can be detected during production, processing, distribution and handling, as well as at all stages of slaughtering, especially in pre-cooling and evisceration, where more contaminated carcasses are generally observed^{5,24}. However, environmental factors such as temperature may contribute. The temperature and its impact on the growth kinetics of *Salmonella* have a directly related effect on the proliferation and maintenance of the bacteria in the food²⁴. It is observed that in chicken cuts *Salmonella* development can be initiated from 16°C⁴. Figure 1 shows the prevalence of different *Salmonella* spp., serotypes found in the investigated studies.

S. Enteritidis is a facultative intracellular pathogen responsible for food poisoning in humans called salmonellosis and was the most prevalent serotype (28.7%) in this study. In addition, it has been evidenced that the contamination of chickens by this pathogen, especially in carcasses, is related to the broiler chickens environment that may be contaminated, allowing the dissemination of this bacteria soon after slaughter^{25,26}. In addition, contamination of chickens by this bacterial genus can

also occur through the manipulators contaminated hand or contact with feces and contaminated water.

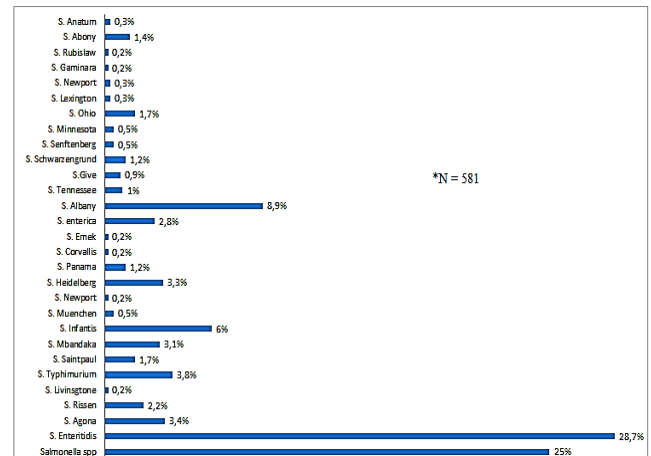


Figure 1: Prevalence of different serotypes of *Salmonella* spp., found in commercialized chicken in different Brazilian states in studies published between the years 2008-2018.

Those infected by this serotype may present gastrointestinal infection, whose symptoms, such as abdominal pain, diarrhea, low fever and vomiting, appear about 12 to 36 hours and may last up to 72 hours, however, clinical cases that evolve to fatality are rare^{27,28}.

In addition, *S. Enteritidis* has been associated with cases of self-limited enterocolitis in high-class population and one of the main causes of death in places where extreme poverty exists, such as sub-Saharan Africa. In immunocompromised patients with salmonellosis, on the other hand, is one of the main responsible for causing infections and septicemias²⁹.

It was recorded that, in 25.0% of the findings, they did not present the *Salmonella* serotype identification, which may contribute to the lack of understanding of the epidemiological characteristics of this type of bacteria in chickens. This makes it difficult to develop more specific public policies to combat these pathogens since there is no knowledge of the epidemiological situation of the country, relating to different foods, serotypes and bacterial species.

CONCLUSION

Taking into account the period selected for the recovery of the data presented in this study, it can be inferred that it is a subject scarcely explored, considering the number of studies performed and the Brazilian states contemplated. This masks the real problem magnitude.

However, it was observed that 7,3% of the samples collected in this study were contaminated by *Salmonella*, with the *S. Enteritidis* serotype being the most prevalent, which presents a considerable risk to the health of those consumed who may consume these contaminated foods.

Finally, it is important to carry out this type

study, in order to show this problem, as well as to serve as a subsidy for the development of appropriate, political or legislative, measures that improve this panorama.

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interests.

CORRESPONDING AUTHOR

Francisco Patricio de Andrade Júnior

Post-Graduate Program in Natural and Synthetic Bioactive Products

Federal University of Paraíba, João Pessoa – PB, Brazil

e-mail: juniorfarmacia.ufcg@outlook.com

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