

THE CONTAMINATION PREVALENCE OF BACTERIAL SEROVARS OF CHICKEN AND BEEF FROM RETAIL AND WHOLESALE MARKETS BY *SALMONELLA* SPP. IN WINDHOEK, NAMIBIA

Salmonella infection in humans is a major public health problem worldwide. There is an increasing concern with this pathogen due to the emergence and spread of antibiotic resistant and potentially more pathogenic strains. Failure to control Salmonella in a country presents a potential problem for other countries. To minimise the burden of this pathogen, it is helpful to monitor Salmonella serovars distribution in many countries, implement Salmonella control measures throughout the food production chain, and monitor the effectiveness of the control measures.

This study investigated the prevalence and the serovars distribution of Salmonella isolated from chicken and beef samples from retail and wholesale markets in Windhoek, Namibia. Chicken (138) and beef (138) samples were analysed for the presence of Salmonella at the Central Veterinary Laboratory in Windhoek. Out of 276 samples of chicken and beef that were analyzed for the presence of Salmonella, 7 % (n = 19) were found to be positive. In beef samples, 14 % (n = 19) were found to be positive for Salmonella. In chicken samples, 0 % (n = 0) tested positive for Salmonella. The prevalence of Salmonella in beef was higher; hence there was a significant difference ($p < 0.001$) between the two products. Salmonella enterica serovar Fulda was the most prevalent with 58 % (n = 11), followed by Salmonella enterica serovar Javiana with 42 % (n = 8). The prevalence rate of Salmonella was 56 % (n = 19) in the city centre, and maintained a prevalence rate of 0 % in the 10 other localities where samples were taken.

This study has helped to bridge the gap in knowledge by establishing the prevalence rate of Salmonella in chicken and beef in retail and wholesale markets in Windhoek, Namibia. It is recommended that the Hazard Analysis Critical Control Points (HACCP) system should be made compulsory to all local food processing establishments, including abattoirs and retail markets in the country.

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Introduction

This study could be the first study done on the prevalence of *Salmonella* in chicken and beef in retail markets in Windhoek, Namibia. There is very little knowledge documented on the subject in the Namibian context, hence the importance of this study.

Foodborne diseases are an important cause of morbidity and mortality worldwide and they are among the serious health problems in developing countries [1]. Due to genetic and environmental diversity, bacterial serotypes are adapted to live in a wide variety of hosts using pathogenic and non-pathogenic means of surviving depending on the environmental conditions [2].

There is an increasing concern with this pathogen due to the emergence and spread of antibiotic resistant and potentially more pathogenic strains [3]. Epidemiological studies have shown that foods of animal origin are among the most important sources of foodborne diseases [4, 5]. Food products are usually contaminated with pathogens during the production, processing, distributing and retailing in the market [6]. According to Scallan et al. [7], human salmonellosis is one of the most frequently occurring foodborne diseases worldwide. Over the past couple of decades the incidence of foodborne salmonellosis has increased considerably in the industrialized world and has reached epidemic proportions in several countries [8]. The increase is the result of a combination of factors, including (i) more intensive farming and increased industrialization of all stages of food production, (ii) changes in food handling practices, eating habits and the storage, distribution, and preparation of food, and (iii) more centralized food production and more international trade in food [9]. These changes have brought with them new problems in food hygiene and have greatly facilitated trans-boundary dissemination of *salmonella* as well as other foodborne pathogens [10].

The consumption of contaminated ready to eat foods including beef, have been documented to serve as vehicles for the transmission of several bacterial pathogens and food-borne outbreaks. Pathogens can survive in the food products, especially in meat, until distributed in the food markets [11].

Failure to control *Salmonella* in a country presents a potential problem for other countries. To minimise the burden of this pathogen, it is helpful to monitor *Salmonella* serovars distribution in many countries, implement *Salmonella* control measures throughout the food production chain, and monitor the effectiveness of the control measures [12].

Although most infections produce mild gastroenteritis, lives threatening disseminated infections are common among elderly and immunocompromised patients. As it has been mentioned at the beginning, there is very little known on the subject, a few studies done on foods of animal origin in Namibia have shown that *Salmonella* is prevalent in the country. Public health facilities do not test stool samples of suspected cases, they only resort to treating them. Nonetheless, *Salmonella* infection is a major public health problem worldwide [13].

Literature review

Most importantly: to also explain Salmonellosis, the origin and history of *Salmonella* as multiple species, the epidemiology and the general characteristics of the bacteria. The morphology, classification, nomenclature, and serotyping of *Salmonella* will also be explained.

Salmonellosis is a major cause of bacterial enteric illness in both humans and animals [14]. Infection with *salmonella* in humans and animals primarily causes self-limiting gastro intestinal infections with mild to moderate symptoms, including fever, abdominal cramps, and diarrhoea [15]. More severe clinical outcomes, including death, may occur in cases of bacteraemia or enteric fever (typhoid), which is often characterized by severe headaches, and high fever but no diarrhoea [16]. The symptoms are usually self-limiting and typically and resolve within two to seven days [17].

In a small percentage of cases, septicaemia and invasive infections of organs and tissues can occur, leading to diseases such as osteomyelitis, pneumonia, and meningitis [18]. People who are very young, very old, or immunocompromised are most susceptible to these severe manifestations of salmonellosis, which typically require antimicrobial therapy

[19]. The number of salmonella human isolates reported to the Centres for Disease Control has been steadily increasing since 1977, and in 1983 there were over 38,000 salmonella isolates [20]. Despite improvements in sanitation and careful monitoring of food processing, large outbreaks of salmonellosis continue to occur when food becomes contaminated.

Salmonellosis can be spread by chronic carriers who potentially infect many individuals, especially those who work in food related industries [21]. Factors contributing to the chronic carrier state have not been fully explained, on average, nontyphoidal serotypes persist in the gastrointestinal tract from six weeks to three months, depending on the serotypes [21]. According to Pui et al. [21], only about 0.1% of nontyphoidal *Salmonella* cases are shed in stool samples for periods exceeding one year. The authors further explains that about 2 to 5% of untreated typhoid infections result in a chronic carrier state. Up to 10% of untreated convalescent typhoid cases will excrete *S. Typhi* in feces for one to three months and between 1 and 4% become chronic carriers excreting the microorganism for more than one year [22].

Methodology

The purpose of this chapter is to describe and justify the research design that was used in this study. The study population, sample and sampling procedure, and data analysis will be explained.

Research design

The research was a cross-sectional, descriptive quantitative study design to estimate prevalence and frequency distribution of serovars of *Salmonella* in chicken and beef from retail markets in Windhoek, Namibia. One in which the investigator primarily uses postpositivist claims for developing knowledge (i.e., cause and effect thinking, reduction to specific variables and hypotheses and questions, use of measurement and observation, and the test of theories), employs strategies of inquiry such as experiments and surveys, and collects data on predetermined instruments that yield statistical data (Creswell, 2003). In quantitative research, relationships between variables are quantified.

Population

The target population is the collection of individuals about whom we want to draw conclusions or inferences [23]. The target population of this research is defined as ready to chicken and beef in selected retail and markets in 2015.

Samples

Samples used in this study were from chicken and beef from retail and wholesale markets in Windhoek, Namibia.

Sample size

A convenient sampling technique was used to select the samples that were used for the study, for example, every third pack of chicken and beef on the shelf depending on sample size was selected. A minimum of 138 samples in each group was calculated using the following formula:

$$n = \frac{z^2 pq}{d^2} = \frac{(1.96)^2 0.1 * 0.9}{(0.05)^2} = 138$$

Sampling plan

The study investigated the prevalence of *Salmonella* in ready to eat chicken and beef from retail and wholesale markets. In retail and wholesale shops, samples that were presented for *Salmonella* analysis were selected randomly based on the producers, 138 chicken and 138 beef samples were purchased at 17 retail stores in Windhoek. Since this study was a laboratory based research, the isolation and identification of *Salmonella* contamination was done on all chicken and beef samples randomly selected from retail and wholesale shops at the Central Veterinary Laboratory, Windhoek, Namibia. A convenient sampling method was used whereby all the *Salmonella* isolates were included as samples until the minimum sample size for the study was reached.

Procedure

The study was conducted on chicken and beef from local retail and wholesale markets by analysing ready to eat chicken and beef in Windhoek, Namibia. The sample of chicken and beef products was collected from the selected retail and wholesale, and transported to the laboratory, for salmonella testing. *Salmonella spp.* isolated in 2015 was used to determine the prevalence and serovars of *Salmonella spp.* in Windhoek, Namibia. A total number of 276 samples, 138 chicken and 138 beef samples were purchased at 17 retail stores in Windhoek. The analysis was done to determine the prevalence, identifying the existing serovars of *Salmonella* in retail and wholesale markets in Windhoek, Namibia.

Results

The purpose and objectives of this study was to establish the prevalence and serovars diversity of *Salmonella* in chicken and beef from selected retail shops in Windhoek, Namibia. Therefore, the results are presented based on the purpose and study objectives. Fisher's exact test will be used to show statistical significance in the prevalence of *Salmonella* between chicken and beef. Lastly, the prevalence rate of *Salmonella* per locality will be described.

This study assessed the prevalence and or frequency of contamination of beef and chicken by *Salmonella* serovars in retail markets in Windhoek, Namibia. This is the first documented study on the prevalence of *Salmonella* in beef and chicken, in retail markets in Windhoek, Namibia. The results of this study are presented into four major parts; (1) Prevalence of *Salmonella* in beef. (2) Prevalence of *Salmonella* in Chicken. (3) Prevalence of *Salmonella* in Beef and Chicken using Fisher's exact test to show if there were statistical differences. (4) Distribution of *Salmonella* serovars isolated from chicken and beef.

Prevalence of *Salmonella* in beef

From a total of 138 samples of beef that were tested for the presence of *Salmonella* at the Central Veterinary Laboratory (CVL), 14 % (n = 19) were found to be positive for *Salmonella*. Only meat samples were collected for analysis.

Prevalence of *Salmonella* in chicken

A total number of 138 samples of chicken that were tested for the presence of *Salmonella* at the Central Veterinary Laboratory (CVL), 0 % (n = 0) all 138 samples tested negative for *Salmonella*.

Prevalence of *Salmonella* in chicken and beef

Altogether, a total number of 276 samples of chicken and beef were collected from June 2015 to August 2015. From a total number of 276 chicken and beef samples analyzed at the Central Veterinary Laboratory (CVL) in Windhoek, Namibia, 7 % (n = 19) tested positive for *Salmonella*. The *Salmonella* prevalence rate per individual product is shown in Table 1 below.

TABLE 1. THE PREVALENCE RATE OF *SALMONELLA* PER INDIVIDUAL PRODUCT AND THE GENERAL PREVALENCE RATE ALTOGETHER

Product	No of <i>Salmonella</i> isolates	% prevalence rate per product	% total prevalence rate (N = 276)
Chicken	0	0 (N = 138)	0
Beef	19	14 (N = 138)	7
Total	19	-	7

The prevalence rate of *Salmonella* in chicken samples (n = 138) was 0 %, where as in beef samples (n = 138), the prevalence rate was 14 %.

TABLE 2. FISHER'S EXACT TEST TO DETERMINE *SALMONELLA* CONTAMINATION LEVELS OF SIGNIFICANCE BETWEEN CHICKEN AND BEEF

Product	<i>Salmonella</i> positive (%)	<i>Salmonella</i> negative (%)	Total (%)
Chicken	0 (0.00)	138 (100)	138 (100)
Beef	19 (13.77)	119 (86.23)	138 (100)
Total	19 (6.88)	257 (93.12)	276 (100)
		P < 0.001	

There was a significant difference (p < 0.001) of the prevalence of *Salmonella* between chicken and beef samples, since the p - value was less than 0.05.

TABLE 3. DISTRIBUTION OF *SALMONELLA* SEROVARS ISOLATED FROM CHICKEN AND BEEF AND THE PREVALENCE

<i>Salmonella</i> serovars	No of isolates	Prevalence (%) (N = 19)
<i>Salmonella</i> enterica serovar Javiana	8	42
<i>Salmonella</i> enterica serovar Fulda	11	58
Total	19	100

Salmonella enterica serovar Fulda is the most prevalent with 58 % (n = 11), followed by *Salmonella enterica* serovar Javiana with 42 % (n = 8).

The prevalence rate of *Salmonella* was 56 % (n = 19) in the city centre, and maintained a prevalence rate of 0 % in the 10 other localities where samples were taken.

Conclusion

In conclusion, this study has shown that *Salmonella* spp. are prevalent in retail and wholesale markets in Windhoek, Namibia. In this study, the general prevalence of *Salmonella* in chicken and beef from retail markets was found to be 7%, which is however lower when compared to many developed and developing countries around the world. This could be due to good hygiene practice during processing and handling in such retail shops. On the other hand it could be because of the intervention strategies that are put in place from the feed mill and subsequent controls put in place during the initial breeding, hatching, growing and transportation phases before the processing and preparation of the final product. This could also be due to effective implementation of the HACCP system in the chicken and beef production plants and retail markets involved in the present study.

Salmonella enterica serovar Fulda was the most prevalent *Salmonella* serovar in retail and wholesale markets in Windhoek, Namibia, representing (n = 11) 58% and *Salmonella enterica* Javiana with (n = 8) 48% isolates in beef. These results demonstrate that *Salmonella enterica* serovar Fulda could be among the top serovars that cause salmonellosis in Windhoek, Namibia.

City centre was the only locality that had samples that were contaminated with *Salmonella*, and the rest of the other localities were found to have the prevalence rate of *Salmonella* to be 0%. Overall, the findings from the present study show that the prevalence rate of *Salmonella* varies from region to region.

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