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**ScienceDirect**

Procedia Food Science 5 (2015) 125 – 128

**Procedia**  
Food Science

International 58th Meat Industry Conference “Meat Safety and Quality: Where it goes?”

## The presence of *Salmonella* spp. in Belgrade domestic refrigerators

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### Abstract

The probability of contamination of domestic refrigerators seems to be greater for *Salmonella*, than other, distinctly psychrotolerant bacteria. This survey investigated *Salmonella* spp. contamination of domestic refrigerators in households ( $n = 100$ ). The presence of *Salmonella* species was found in 13.95% of households that kept eggs in designated egg storage in refrigerators ( $n = 86$ ). We identified 12 serotypes of *Salmonella* spp. with antimicrobial resistance, of which 50% were identified as *S. Typhimurium*. The results obtained confirm the need to strongly advise consumers how to properly arrange different foodstuffs inside household refrigerators.

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Peer-review under responsibility of scientific committee of The 58th International Meat Industry Conference (MeatCon2015)

**Keywords:** *Salmonella* spp.; domestic refrigerators; households; consumer

### 1. Introduction

Home is a multifunctional setting in which there is a constant transfer of pathogens into and out of home. In the domestic setting various surfaces can harbour pathogenic organisms, thus being a potential source of food poisoning, possibly through cross contamination. Potential pathogens from sources such as raw foods, persons, and animals can be transferred between inanimate and animate surfaces through either direct or indirect contact<sup>1</sup>.

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According to the EFSA Report 2013, 32.7% of outbreaks of foodborne illness registered in Europe occur in our domestic kitchens, due to inadequate hygienic behaviour of consumers when preparing foods<sup>2</sup>. *Salmonella* spp., which leads to more than 1.2 million illnesses, with approximately 23.000 hospitalizations and 450 deaths every year, is the major cause of foodborne disease in the United States<sup>3</sup>. Among more than 2500 identified *Salmonella* serotypes, *Salmonella enterica* serotype Enteritidis has been reported as the most commonly isolated serotype, responsible for 18% of laboratory-confirmed *Salmonella* infections in 2012<sup>4,5</sup>. The interior surfaces of household refrigerators are at risk of becoming contaminated with foodborne pathogens, increasing the risks of cross-contamination to other food items. According to previous studies, the probability of refrigerator contamination seems to be greater for *Salmonella*, than *Y. enterocolitica* and *L. monocytogenes*, distinctly psychrotolerant species<sup>6</sup>, while *Salmonella* tends to be a mesophilic microorganism. *Salmonella* evidently comes from several specific foodstuffs, such as eggshells, raw meats and fresh vegetables. This study findings highlight the importance of adequate temperature control and thorough, regular cleaning of domestic refrigerators to ensure food safety, and of effective cooking as the last link in the domestic food service chain<sup>7</sup>. This study examined the incidence of *Salmonella* spp. on the surfaces of domestic refrigerators, to provide insights into the true burden of, and the risks posed by, this pathogen in domestic refrigeration systems.

## 2. Materials and methods

### 2.1. Data collection

This study was conducted during a five month period, from September to January 2012, and included 100 households from the Belgrade area, Serbia. Participants were recruited randomly and selected by their willingness to participate when confronted by a door-to-door screener. They were briefly informed about the aim of the study and what would be the methods applied in their home. Data were collected with the consent of family members and from consumers who had volunteered to participate in this research. All respondents were 18 years or older, and were responsible for food preparation and cooking in their households. Consumers were not offered any compensation for their participation in the survey and obtained answers and collected data were anonymous. The questionnaire was prepared in consultation with researchers who have experience in the collecting and processing of data obtained by questionnaire. A questionnaire was designed with questions related to food safety and cleaning habits, and was administered to the responsible persons in each house. All the data was only evaluated in order to find if reported behaviours are reflected in microbiological results.

### 2.2. Sampling and microbiological analyses

Swabs were taken from defined points in each home – group sample swab was taken from six places in the area of the refrigerator reserved for the egg storage. Swabs were taken after the finished interview, using one cotton swab moistened with Buffered Peptone Water (BPW, Merck). All samples, in total 86, were transported to the laboratory in a refrigerated box and analyzed as soon as they arrived in the laboratory (within 12 h). Determination of the presence of *Salmonella* spp. was according to ISO standards<sup>8</sup>. Grown suspect colonies of *Salmonella* spp. were identified by biochemical and serological polyvalent serum (Institute of Public Health Dr Milan Jovanovic Batut, Serbia).

## 3. Results and discussion

The 2003 World Health Organization (WHO) report concluded that about 40% of reported food-borne outbreaks in the WHO European Region occur in private homes<sup>9</sup>. Therefore it is important to know how to prevent contamination and to know where the contamination occurs.

Of the 100 households surveyed, 14% of them did not hold eggs in compartments on the refrigerator door. The presence of *Salmonella* spp. was found in 13.95% households that stored eggs in the refrigerator door ( $n = 86$ ). We identified 12 serotypes of *Salmonella* spp. showing antimicrobial resistance, of which 50% were identified as *S. Typhimurium*. A consumer survey can be a useful instrument to collect information that yields concrete evidence for

a requirement for educational measures. In our results of the questionnaire, it was not possible to make a correlation between the answers and the results of analyses for *Salmonella*, since it seems that most of the answers given in the questionnaire were not consistent with analytical data obtained in this study. This supports the results of other authors<sup>1,10,11,12</sup> who referred to the importance of conducting direct observations as clear discrepancies are identified between observational and self-reported data in studies of food handling behaviours. Most of respondents were female (91.67%), and only three of the examined consumers had one child (data not shown). Some of the demographic and consumer knowledge data are shown in Table 1. All consumers where *Salmonella* was isolated from their refrigerator had heard of this bacterium (data not shown) and most of them properly linked this pathogen with food sources (Table 1). One-quarter of the participants where the *Salmonella* spp. was isolated reported food poisoning in the last year, while in almost one-fifth (19.77%) of the cases where food poisoning was reported, *Salmonella* spp. was not isolated.

Table 1. Isolated serotypes of *Salmonella* in domestic refrigerators, demographic parameters and consumer knowledge.

Respondents data							
<i>Salmonella</i> spp.	Age	Professional status	Level of education	Profession related to food safety	Help in the kitchen	Link with <i>Salmonella</i> source	Food poisoning in the last year
<i>S. Typhimurium</i>	45-54	Employed	High school	Yes	Yes	Egg	No
<i>S. Typhimurium</i>	25-34	Employed	High school	No	Yes	Pork	Yes
<i>S. Typhimurium</i>	>75	Retiree	High school	No	No	Egg	No
<i>S. Typhimurium</i>	25-34	Employed	High school	Yes	Yes	Egg	Yes
<i>S. Typhimurium</i>	25-34	Employed	Faculty	Yes	Yes	Egg and poultry	No
<i>S. Typhimurium</i>	55-64	Retiree	Faculty	No	Yes	Egg and poultry	No
<i>S. Enteritidis</i>	55-64	Retiree	High school	No	Yes	Egg	No
<i>S. Enteritidis</i>	55-64	Retiree	Faculty	Yes	Yes	Egg	Yes
<i>S. Enteritidis</i>	55-64	Retiree	Faculty	No	No	Egg	No
<i>S. Enteritidis</i>	>75	Retiree	Faculty	No	Yes	Egg	No
<i>S. Enteritidis</i>	55-64	Retiree	High school	No	Yes	Egg	No
<i>S. Enteritidis</i>	25-34	Employed	High school	No	No	Egg	No

#### 4. Conclusion

Findings from this survey are worrisome because *Salmonella* was isolated in such large percentage of domestic refrigerators. The results obtained in this study have revealed the need to develop some education campaigns in Serbia designed to educate consumers, regarding safe food handling practices and cleaning habits.

## Acknowledgement

This paper was supported by the Ministry of Education, Science and Technological Development, Republic of Serbia, Project “Selected biological hazards to the safety / quality of food of animal origin and the control measures from farm to consumer” (31034).

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