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Contamination by *Salmonella* spp., *Campylobacter* spp. and *Listeria* spp. of most popular chicken- and pork-sausages sold in Reunion Island

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ABSTRACT

One of the most popular meat products of the local "cuisine" is sausage composed with 100% chicken or 100% pork. In this study, we aimed to determine the presence of *Salmonella* spp., *Campylobacter* spp. and *Listeria* spp. in chicken- and pork-sausages, quantify *Salmonella* spp. population and identify the factors that could be associated with contamination in the outlets. Two hundred and three batches of pork and chicken sausages were randomly collected from 67 local outlets (supermarkets, groceries and butcher shops). *Salmonella* spp. was detected in 11.8% (95% confidence interval (CI): [10.0; 13.5]) of samples, *Campylobacter* spp. in 1.5% [0.7; 4.2] and *Listeria monocytogenes* in 5.9% [4.4; 7.3]. Most probable number of *Salmonella* spp. varied between 6 cfu per gram to 320 cfu per gram. *Salmonella* serotypes isolated from pork and chicken sausages were *S.* Typhimurium (45.8%), *S.* London (20.8%), *S.* Derby (16.7%), *S.* Newport (8.33%), *S.* Blockley (4.2%) and *S.* Weltevreden (4.17%). Using a logistic (mixed-effect) regression model, we found that *Salmonella* spp. contamination was positively associated with sausages sold in papers or plastic bags and no control of rodents. Chicken sausages were associated with a decreasing risk of *Salmonella* contamination. *Listeria monocytogenes* contamination was positively associated with the presence of fresh rodent droppings in the outlet and negatively when the staff was cleaning regularly their hands with soap and water or water only. All the sampled outlets of Reunion Island were not equivalent in terms of food safety measures. Increasing awareness of these traders remains a cornerstone to limit the presence of *Salmonella* spp. and *Listeria* spp. in sausages, particularly in a tropical context (high temperature and humidity).

1. Introduction

Non-typhoidal *Salmonella* spp. remains a public health burden worldwide, causing 1.6 billion of gastroenteritis and 3 millions of deaths (Bhunia, 2008). The European Food Safety Authority (EFSA) has identified 82,694 salmonellosis cases in humans in 2014 in the European Union (EFSA, 2016). But *Salmonella* spp. is not only of great concern in temperate countries but also in tropical countries where warmer temperatures and maybe differences in eating behavior could contribute to enteric and particularly *Salmonella* infections (Zhang et al., 2010). Products of animal origin are generally associated with *Salmonella* infection but poultry meat and pork are the most often incriminated foods (Forshell and Wierup, 2006). *Campylobacter* is the principal bacterial cause of gastroenteritis in many developed countries but also in developing countries (Fitzgerald et al., 2001; Cardinale et al., 2005); the most significant risk factors identified for infection have included the consumption and handling of raw or undercooked poultry or other meats, raw milk and surface waters (EFSA, 2009) but *Campylobacter* was also isolated from sausages (Konell et al., 2014). *Listeria monocytogenes* is a foodborne pathogen that is found in the natural environment and is consequently detected in many types of food products; generally in fish and milk products, this pathogen was also isolated from pork and poultry products such as deli meat products (Garrido et al., 2009) and in cooked ham and cured dried pork sausage respectively (Cabedo et al., 2008).

In Reunion Island, a tropical French island in the Indian Ocean, east of Madagascar and west of Mauritius, the multicultural population mostly eats chicken and pork and they particularly love the locally-produced sausages. These sausages are 100% chicken- or pork-made and composed of lean, fat, but also skin (Chambre des arts et des metiers, 2012) and because the skin is considered as headquarters of *Salmonella* spp., these

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products could be at-risk for the consumers. In 2010, the sales volume of poultry was 8696 tons (Crete d'Or, 2012). Currently, the consumption of poultry meat is estimated at 34 kg per year and per capita, while it is 24.6 kg and 12.8 kg, in France and in the world respectively. Only 33.0% of the local demand for poultry is covered by local production. The pork production in 2012 was about 11,853 tons of carcasses. The coverage rate of the demand for pork was 49.2% (Federation Regionale des Cooperatives Agricoles de La Reunion, 2013).

To date, no information about the impact of *Salmonella*, *Campylobacter* and *Listeria* in this food preparation is available. Yet, Reunion Island depends on European regulation 2160/2003 for food hygiene, and then no *Salmonella* should be recovered from chicken or pork sausages. Furthermore, recent studies have shown that *Salmonella* and *Campylobacter* prevalence was high in poultry and pig production (Cardinale et al., 2010; Henry et al., 2011, Henry et al., 2012); and then efforts should be made to avoid contamination of the further stages of the industry and especially of the final animal products as these sausages.

Thus, this study was aimed to determine the presence of *Salmonella* spp., *Campylobacter* spp. and *Listeria* spp. in chicken- and pork-sausages, quantify *Salmonella* population and identify the factors that could be associated with contamination in the outlets.

2. Materials and methods

2.1. Visited outlets

The study was conducted between March 2012 and August 2012 in outlets of Reunion Island. Sixty seven outlets have been randomly sampled from a local census (170 in total) and visited once, i.e. 19 butcheries, 28 supermarkets and 20 groceries (Fig. 1) and their distribution was spread all over the island.

2.2. Data collection

In each outlet, 3 to 6 different categories of sausages depending on availability (chicken and pork, smoked versus unsmoked, fresh vs packaged sausages) were bought. In total, 203 sausage batches have been bought (55 in butcheries, 108 in supermarkets and 40 in groceries). Sausages are manufactured locally in butcheries and groceries but in supermarkets, sausages could be made locally or bought from sausage factories. These samples were directly placed into a sterilized plastic bag in a cooler box with ice packs for no > 1 h before delivery and immediate culture at the laboratory. For each outlet, data on manufacturing practices and storage were collected from a questionnaire on the following topics: general characteristics, cleaning and disinfection procedures, staff hygiene, presence of rodents and other domestic animals and waste management. Questionnaire was composed with 41 closed questions only in order to limit any misinterpretation. A pre-test on three outlets was conducted to validate the questionnaire. The 30 minutes questionnaire was made by the same operator. The answers were cross-checked by direct observation from the operator and corrected if necessary. Only managers were interviewed. The data were entered into a database using Access® software.

2.3. Salmonella isolation, identification and quantification

Salmonella isolation and quantification were realized according the CEN ISO/TS 6579 method, part 1 and 2 published in 2012. Samples

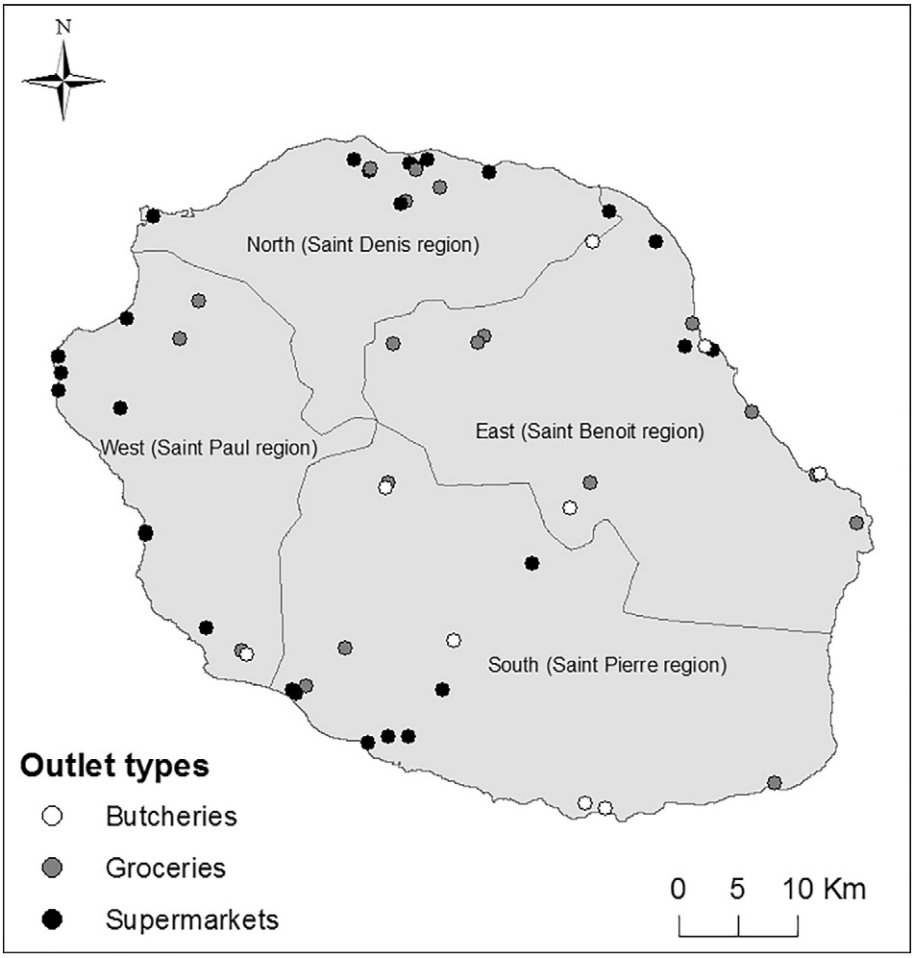

Fig. 1. Location of outlets and type of outlets, Reunion Island, 2012.