

Salmonella in pork retail outlets and dissemination of its pulsotypes through pig production chain in Chiang Mai and surrounding areas, Thailand

Prapas Patchanee^a, Kankanok Tansiricharoenkul^a, Tunyamai Buawiratler^b, Anuwat Wiratsudakul^{c,d}, Kittipat Angchokchatchawal^c, Panuwat Yamsakul^a, Terdsak Yano^a, Phacharaporn Boonhot^a, Suvichai Rojanasatien^a, Pakpoom Tadee^{a,*}

^a Department of Food Animal Clinics, Faculty of Veterinary Medicine, Chiang Mai University, Chiang Mai, Thailand

^b The Fifth Regional Livestock Office, Department of Livestock Development, Ministry of Agriculture and Cooperatives, Chiang Mai, Thailand

^c Department of Clinical Sciences and Public Health, Faculty of Veterinary Science, Mahidol University, Nakhon Pathom, Thailand

^d The Monitoring and Surveillance Centre for Zoonotic Diseases in Wildlife and Exotic Animals, Faculty of Veterinary Science, Mahidol University, Nakhon Pathom, Thailand

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ABSTRACT

Salmonella spp. is acknowledged as a significant zoonotic foodborne pathogen throughout the world. Contaminated pork consumption is considered as a main cause of human salmonellosis. In the later stage of the pig production chain, poor hygiene and unsuitable storage conditions in retail outlets are considered to be key factors linked to the risk of *Salmonella* infection. The purpose of current study, which was conducted throughout April 2014 to September 2014, was to determine the prevalence and characteristics of *Salmonella* spp. in pork sold at the retail stage in wet markets and supermarkets in the Chiang Mai urban area of Thailand. Additionally, clonal relations between *Salmonella* strains described in this study and those identified in earlier study from the same geographical area were considered. It is provided as a means of contributing to current knowledge regarding *Salmonella* epidemiology with an ultimate aim of improved food security and consumer protection in this region. From a total of 82 pork samples analyzed in this study, 41% were positive for *Salmonella*, with prevalence of 73.2% from wet markets ($n = 30/41$) and 9.8% from supermarkets ($n = 4/41$). Twelve *Salmonella* serovars were identified, *S. Rissen* being the most commonly encountered. Antibiotic resistance of the isolates was highest for ampicillin and tetracycline (53%), followed by streptomycin (44%). Pulsed-field gel electrophoresis (PFGE) and subsequent geographical distribution analysis indicated that the clonal *Salmonella* strains originated from multiple sources had been spread over a wide area. The existence of a common pig supply chain “farm-slaughterhouse-retail” transmission route is inferred. Continuous monitoring of *Salmonella* along the entire production chain is needed to reduce contamination loads and to ensure the safety of pork products for end consumers.

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1. Introduction

Salmonella spp. is considered to be one of the most significant zoonotic foodborne pathogens and is a major public health concern throughout the world (Visscher et al., 2011; Magwedere et al., 2015; Gibert, 2015). Approximately 95% of salmonellosis in humans is related to animal-origin food consumption (Lynne et al., 2015);

contaminated, undercooked pork are implicated in several human cases (Giovannini et al., 2004; Mürmann et al., 2009; Pires et al., 2014).

Salmonella can be introduced into humans at any point along the pig production chain (White et al., 2001; Dorn-In et al., 2009; Wang et al., 2015). At the farm level, *Salmonella*-infected pigs carrying the organisms in their intestinal tracts can spread *Salmonella* to other pigs directly via the fecal-oral route or indirectly through fecal contamination of the environment (Farzan et al., 2006; Hauser et al., 2011). High bacterial loads in pig intestinal tracts can be expected to cause high contamination rates at every level of the production chain (Tadee et al., 2014). The slaughtering procedure itself can be

* Corresponding author.

E-mail addresses: td.pakpoom@gmail.com, td.pakpoom@hotmail.com (P. Tadee).

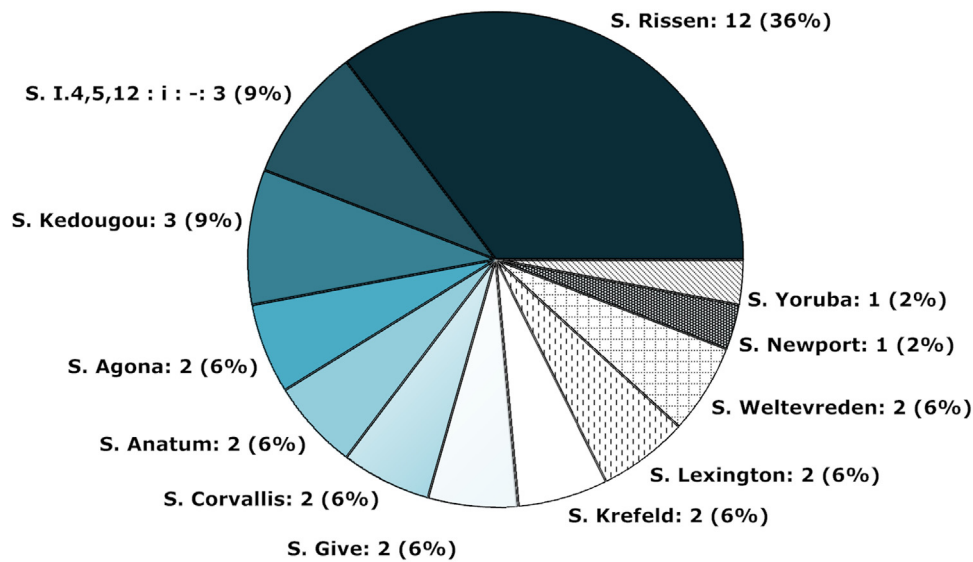


Fig. 1. Distribution of *Salmonella* serovars isolated from pork products from wet markets and supermarkets in the Chiang Mai urban area from April 2013 through September 2014.

a major source of spreading the organism from the pig's intestinal contents to slaughtered carcasses if the processing is not accomplished properly (Swanenburg et al., 2001; Gomes-Neves et al., 2012).

At the later stages of the production chain, the appearance of *Salmonella* on pork at retail markets or butchers results in a high chance of exposure in consumers and is correlated with a large number of human salmonellosis cases (Prendergast et al., 2009; Bollaerts et al., 2010). Appropriate handling and processing techniques, good general hygiene and suitable storage conditions have been suggested as effective means of reducing or stopping colonization activity of *Salmonella* (Berends et al., 1997; Mürmann et al., 2009). Concern about processing procedures is the reason that most health-conscious consumers prefer pork products purchased from a supermarket rather than those obtained from an open marketplace with stalls of fresh food and other items for sales, "wet market" (Hansen et al., 2010). The vacuum sealed packages with origin tracking labels in supermarkets greatly increase the confidence of consumers when they are making their selection (Heather, 2014). Despite these retail practices, there is no guarantee that the pork purchased from supermarkets are free of bacterial contamination (Whittaker et al., 2009).

Tadee and his colleagues demonstrated an association among *Salmonella* pulsotypes at pre-harvest and harvest levels of pig supply chain in Chiang Mai, Thailand (Tadee et al., 2015). Spreading of *Salmonella* from the standard pig farm to slaughterhouse over the wide area was extrapolated. The study, however, included only a limited number of *Salmonella* pulsotyping profiles taken from pork products on sale at a number of retail outlets and butchers. Additional data are required to broaden epidemiological knowledge of *Salmonella* throughout the entire pig production chain in order to improve methods of reducing the risk posed by that organism.

The objectives of this study were to investigate the prevalence and characteristics of *Salmonella* on retail's pork in wet markets and supermarkets in the Chiang Mai urban area, and to determine clonal relationships between *Salmonella* strains described in this study with those *Salmonella* strains identified in the Tadee et al. (2015) study. That expansion of knowledge in *Salmonella* epidemiology could enhance domestic consumer protection and help promote *Salmonella*-free pork through appropriate practices for pork handling and consuming.

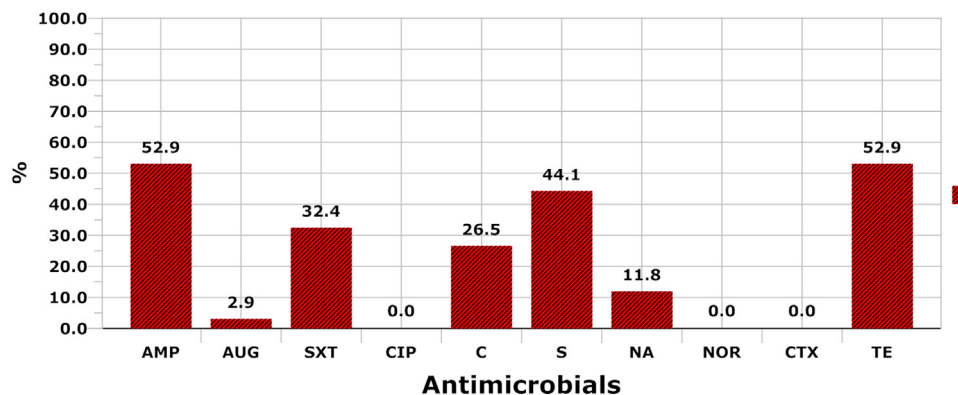


Fig. 2. Antimicrobial resistance prevalence of *Salmonella* isolates originating from pork products at the retail stage from the Chiang Mai urban area between April 2013 and September 2014.

Antibiotic abbreviations: ampicillin (AMP); amoxicillin/clavulanic acid (AUG); sulfamethoxazole-Trimethoprim (SXT); ciprofloxacin (CIP); chloramphenicol (C); streptomycin (S); nalidixic acid (NA); norfloxacin (NOR); cefotaxime (CTX); tetracycline (TE).

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