Antimicrobial resistant genes associated with *Salmonella* from retail meats and street foods

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We examined the antimicrobial resistance of *Salmonella* isolates from 300 meat products (raw beef, chicken meat and street foods). A total of 88 non-duplicate *Salmonella* from 66 (22.0%) retail meat and 22 (7.5%) street food samples were recovered and 11 sources were identified. Among the 88 *Salmonella* isolates, the highest resistance was to tetracycline (23.8%), followed by sulfonamide (63.6%), streptomycin (57.9%), nalidixic acid (44.3%), tetracycline–sulfamethoxazole (19.3%), ampicillin (17.0%), chloramphenicol (10.2%), cephalothin (8.0%), kanamycin (6.8%), clofroxacin (2.2%) gentamicin (2.2%), cefoxitin (2.2%), amoxicillin–clavulanate (1.0%) and ampicillin (1.0%). Sixty–seven percent of the isolates (59/88) were multidrug resistant (MDR). Ten out of 12 resistance genes (*bla* _TEM_, _strA_, _srfB_, _aadA_, _sulI_, _sulII_, _strA_, _strB_, _fluB_, _catA_) were detected. Twelve of the 59 MDR *Salmonella* isolates from sources Typhimurium (6), Newport (3), Agona (1), Albany (1) and Weltevrede (1) had class 1 integrons. The gene cassettes identified were *df*rA1, *df*rV, *df*rA12, *aadA2, sulI* genes and an open reading frame (ORF) of unknown function. Four integrin-positive isolates could transfer resistance phenotypes to the recipient strain, *E. coli* J53 via conjugation. These data revealed that the *Salmonella* isolates recovered from the retail meats and cooked street foods were resistant to multiple antimicrobials, which can be transmitted to humans through food products. The occurrence of mobile genetic elements such as integrions reiterates the roles of food of animal origins as a reservoir of MDR *Salmonella*.

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1. Introduction

The prevalence of multidrug resistant *Salmonella* enterica in foods has been reported in many parts of the world (Chen et al., 2004; Miko, Pries, Schooer & Helmuth, 2005; White et al., 2001; Van, Moutafis, Istvan, Tran & Coloe, 2007) from various host species including food animals as well as processed ready–to–eat meat products (Rhemtong & Chuanchu, 2008; White et al., 2001). Food contamination with multidrug resistant (MDR) bacteria is a major problem for public health, as resistance traits located on mobile genetic elements can be transferred to other bacteria of clinical significance (Miko, Pries, Schooer & Helmuth, 2005; Van, Moutafis, Istvan, Tran & Coloe, 2007). The mechanism of resistance to antimicrobial agents can be due to many factors, such as changes in the bacterial cell wall permeability or target sites, enzymatic drug modifications and energy–dependent removal of antimicrobials via membrane–bound efflux pumps (Chen et al., 2004). Bacteria can exchange resistance genes through transformation, transduction or conjugation. Many resistance genes are located on mobile genetic elements such as plasmids, integrons and transposons. The association of antibiotic resistance phenotypes with the presence of integrons has been well documented (Miko, Pries, Schooer & Helmuth, 2005; Mouri, Henriques, Ribeiro & Correia, 2007; Van, Moutafis, Istvan, Tran & Coloe, 2007). Four classes of integrons have been reported to be associated with resistance gene cassette. Notably, class 1 integrons are the most common type of integrin in MDR gram-negative bacteria and predominate in MDR *Salmonella* (Rhemtong & Chuanchu, 2008).

To date, very little data has been published on the antimicrobial resistance mechanism among *Salmonella* from food sources in Malaysia. The objectives of this study were to determine the antimicrobial susceptibility of *Salmonella* isolated from retail meats and cooked street foods, to characterize the genetic mechanisms within the antimicrobial–resistant phenotypes observed and the presence of class 1, 2 and 3 integrons. In addition, selected isolates were examined for the ability to transfer resistance genes via conjugative transfer of plasmids to *Escherichia coli*.

2. Materials and methods

2.1. Salmonella isolates

We previously reported the prevalence of *S. enterica* in 200 samples of raw beef and chicken meat and 100 samples of street food examined during 2006–2009 (Modarressi & Thong, 2010). The raw beef and chicken