Escherichia coli, its Prevalence and Antibiotic Resistant in Malaysia: A Mini Review

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ABSTRACT

The bacterium Escherichia coli is a Gram negative, facultative anaerobe that ferments glucose/lactose and lives naturally in the gastrointestinal tract of animals and humans. Though most Escherichia coli strains are non-pathogenic and inhibit their host as commensals, few pathogenic ones exist that causes diseases in humans especially in immune-challenged individuals. Pathogenic Escherichia coli can be contracted from the consumption of contaminated foods. The prevalence of Escherichia coli as reported in Malaysia ranged from 22.6 to 88.0%. Majority of the work on E. coli is concentrated on beef samples. Furthermore, most Malaysians eat out; therefore, posing a high risk of ingesting pathogenic Escherichia coli strains. A report on the prevalence and antibiotic resistance of Escherichia coli strains in Malaysia is necessary to create more awareness of the existence of the pathogen in the food chain and subsequently its implication on public health.

Key words: Escherichia coli, Malaysia, non-pathogenic, pathogenic, prevalence

INTRODUCTION

The prevalence of food-borne pathogens in animals, humans, environmental samples or foods of animal and plant origin is a concern worldwide and has caught the attention of researchers, the food industry, health organizations, governments and all stakeholders. Such data gives an idea of the possibility of pathogenic organisms being transferred from any of the afore-mentioned sources to humans and subsequently causing food-borne diseases, illnesses or food poisonings. Studies for tracing the source of human food-borne diseases and/or food poisonings have relied on molecular characterisation of isolates from both humans and their suspected sources to determine their genetic relatedness. Among these important food-borne pathogens are Campylobacters, Salmonellae, Listeria, Staphylococcus, Clostridium, Vibrio, Shigella, Bacillus and Escherichia coli.

Escherichia coli are Gram negative, facultative bacteria that ferment glucose and are members of the family Enterobacteriaceae (Feng and Weagant, 2009). They are widely distributed in the intestine of animals and forms part of the normal intestinal flora that maintains the physiology of a healthy animal (Conway, 1995). Thus most E. coli strains are non-pathogenic but pathogenic strains that cause gastrointestinal illness in humans and opportunistic ones that normally affect immune-compromised patients exists (Nataro and Kaper, 1998). Symptoms of pathogenic E. coli infections include watering diarrhoea, little or no fever, bloody diarrhoea and haemolytic uremic syndrome (Nataro and Kaper, 1998). Reliable and efficient methods of isolating food-borne pathogens are essential for reporting and treatment purposes (Frederick and Nurul, 2011; Adzitey and Nural, 2011; Adzitey et al., 2011a). As such polymerase chain reaction assays that are more efficient, rapid, sensitive and reliable for detecting and genotyping E. coli species have
been evaluated and used (Gomes et al., 2005; Sherfi et al., 2006, 2007; Parekh and Subhash, 2008; Jomezadeh et al., 2009).

The prevalence of E. coli and subsequently it outbreak has been reported in other countries. In South Africa (Muller et al., 2003) reported a prevalent rate of 20% E. coli 0157:H7 from sewage and environmental sources. In Ghana, the presence of E. coli in beef, mutton and chevon sold in some selected market in the Tamale Metropolis has been reported by Adzitey et al. (2010a,2011b). In Trinidad, Hosein et al. (2008) reported a prevalence of 4.5% in ready-to-eat products in supermarkets across the country. An outbreak of E. coli was reported in the United States in 2002 which was associated with the consumption of ground beef (Vogt and Dippold, 2005). In Japan, an outbreak of E. coli 0157:H7 was linked to contaminated radish sprouts (Mermin and Griffin, 1999) In India, Nanu et al. (2007) analyzed raw milk samples collected from farmers belonging to three farmer dairy societies of Kerala and reported a prevalence rate of 31.6%. Mahalakshmi et al. (2011) examined water and sediments samples from the Cuddalore Fishing Harbour and reported maximum values of E. coli to be $5.9 \times 10^4$ cfu mL$^{-1}$ and $4.7 \times 10^4$ cfu g$^{-1}$. In Saudi Arabia, Abureesh (2011) found that 2.5% of 400 pigeon faecal samples were positive for shiga toxin-producing E. coli.

In Malaysia, data on the prevalence of certain food-borne pathogens such as Salmonella, Listeria, Staphylococcus, Campylobacter and E. coli are available (Arumugaswamy et al., 1994; Saleha, 2002; Adzitey et al., 2011c). Nonetheless, data on outbreaks of a particular food-borne pathogen is very scarce if not unavailable. Malaysia consumers as found in most developed nations are also becoming increasingly aware and concern on food safety issues. Few studies on the prevalence and antibiotic resistance of E. coli isolates from Malaysia are available. This mini-review briefly discusses the pathogen E. coli, it prevalence and antibiotic resistance as reported in some samples in Malaysia. By this consumers are being made aware of the existence of both pathogenic and non-pathogenic E. coli species in food products on the market and the need for the government to put up strategies to reduce it occurrences and outbreaks.

**ESCHERICHIA COLI**

*Escherichia coli* was identified by the German paediatrician, Theodor Escherich in 1885 (Escherich, 1885; Neill et al., 1994). The pathogen is Gram negative, rod-shaped, predominant facultative anaerobe widely distributed in the gastrointestinal tract and ferments glucose/lactose (Neill et al., 1994; Conway, 1995). It belongs to the family Enterobacteriaceae, together with *Salmonella, Shigella* and *Yersinia* (Ewing, 1986). The pathogen has long been used to indicate the presence of faecal contamination and frank pathogens and recently being used to indicate the presence of recent faecal contamination and unsanitary processing conditions (Feng and Weagant, 2009). Even though most strains of *E. coli* are considered harmless, opportunistic and pathogenic strains that cause gastroenteritis are present (Feng and Weagant, 2009). The pathogenic group of *E. coli* are enterotoxigenic *E. coli* (ETEC) which causes diarrhoea without fever; enteropathogenic *E. coli* (EPEC), causes traveller's diarrhoea; enterohemorrhagic *E. coli* (EHEC), causes bloody diarrhoea without fever; enteroinvasive *E. coli* (EIEC), causes dysentery-like diarrhoea with fever; enteroaggregative *E. coli* (EAEC), cause non-bloody diarrhoea; diffusely adherent *E. coli* (DAEC) and others that are not yet well characterized (Nataro and Kaper, 1998). Thus the first four groups have been authentically implicated in food and water-borne illnesses and O157:H7 is the prototypic EHEC most often implicated in illness worldwide (CDC, 1999; Nataro and Kaper, 1998; Feng and Weagant, 2009). *Escherichia coli* O157: H7 has also been
implicated in haemorrhagic colitis, haemolytic uremic syndrome and thrombotic thrombocytopenic purpura which are very detrimental (Blackburn and McCarthy, 2000).

Various sources of E. coli transmission to humans and outbreaks have been reported. They include drinking water, recreational water (swimming pool), environmental sources, sewage, sediments and irrigation water, wild animals, domestic animals and pets, livestock, poultry, liver and intestines, meat and meat products, milk and milk products, cheese, fruits and vegetables and their products, ready-to-eat meals (Hosein et al., 2008; Muller et al., 2003; Rad, 2004; Ekici et al., 2004; Zamxaka et al., 2004; Tambekar and Mundhada, 2006; Tambekar et al., 2006; Warsama et al., 2006; Brichtha-Harhay et al., 2007; Oyetayo et al., 2007; Shojaei and Yadollahi, 2008; Mihdhdir, 2009; Adzitey et al., 2011b).

Prevalence of E. coli in Some Selected Foods, Animals and Their Products in Malaysia

The prevalence of Escherichia coli O157: H7 from beef samples purchased from retail stores in Malaysia was reported to be 36% (9/25) by Son et al. (1998). The strains were found to produce Shiga toxin 2 with or without Shiga toxin 1 and had the eae gene and a plasmid size of 60-MDa. They also suggested that the strains may have originated from different sources due to their diversity after being analyzed by antibiograms and profiles of the arbitrarily primed polymerase chain reaction.

Similarly, Apun et al. (2006) isolated E. coli (including Shiga-like toxin producing E. coli (STEC), serogroup O157:H7 and E. coli) from raw beef marketed in Sarawak and Sabah, East Malaysia. Pulsed field gel electrophoresis of some of the isolates revealed that some isolates were closely related while others were non-related.

Apun et al. (2010) carried out a study to assess the occurrence of both pathogenic and non-pathogenic E. coli in bats, birds and rodents in two urban forests and an oil palm plantation located along the Rejang Basin, Sibu in the Sarawak State. They analysed a total of 105 bird hosts, 44 of rodent hosts and 84 bat hosts (which comprises 48 species of birds, one species of rodent and ten species of bats) for the presence of Escherichia coli and reported a prevalence of 43, 18 and 11% in rodents, birds and bats, respectively. They did not detect the slt-I, slt-II, rfbE genes in any of the E. coli isolates. Therefore, they reported that bats, birds, or rodents from their study area did not serve as an important reservoir of Escherichia coli O157:H7 and thus were of no risk in the epidemiologic cycle of emerging enteric bacterial zoonoses in the state of Sarawak, Malaysia.

Sahilah (1997) analyzed beef samples purchased from 4 supermarkets in Selangor and the Federal Territory of Malaysia between March to June 1996 and found that nineteen (76%) of the samples were positive for E. coli O157:H7.

Sukhumungoon et al. (2011) also analysed beef samples imported from Malaysia to Thailand for the presence of E. coli O157 and found 7 positives out of 31 beef samples examined (22.6%). Six E. coli isolates belonged to the E. coli O517:H7 serogroup and had the stx1', stx2' and eae' genes and one isolate belonged to O116:H31 serogroup and had the stx1', stx2' and eae' genes. They found that beef imported from Malaysia to Thailand had E. coli strains that were more heterogeneous compared to E. coli strains isolated from Thailand beef.

A cross sectional study was conducted in the Municipal Council jurisdiction of Kota Bharu on 382 food premises to evaluate their hygienic standard based on standard form used by the district health office. An E. coli count of 27% was observed and they were detected more in staple foods than in snacks (Zaliha and Rusli, 2004).
Chye et al. (2004) observed an overall prevalence of E. coli from 380 dairy farms in Peninsular Malaysia in raw milk samples to be 65% (600/930) and 33.5% for only E. coli O517:H7. They reported on the biological quality of raw milk and found the counts of E. coli alone from the Southern, Central, Eastern and Northern region to be $1.5 \times 10^5$, $5.4 \times 10^5$, $4.8 \times 10^5$ and $1.9 \times 10^5$, respectively. The prevalence of E. coli was 68.5% (261/381), 57.2% (115/201), 72.2% (91/126) and 59.9% (133/222) for the Southern, Central, Eastern and Northern region, respectively. The incidence of E. coli O571:H7 was 28.6% (106/381) for the Southern, 38.8% (78/201) for the Central, 38.5% (46/126) for the Eastern and 35.3% (79/222) for the Northern region.

In ducks (Adzitey et al., 2010b) sampled duck intestines, duck wash water (water used for washing ducks), duck faeces and soil samples collected from duck farms and wet markets, and reported an overall occurrence of 79% (122/155) for E. coli. These were distributed as 88% (53/60), 82% (41/50), 72% (18/25) and 50% (10/20) for faeces, intestines, soil and wash water samples, respectively. They also found E. coli O517 in the thirty two duck intestines, eight duck faeces, four duck soil samples and two duck wash water samples.

**RESISTANCE OF E. COLI ISOLATED FROM MALAYSIA TO ANTIBIOTICS**

Alhaj et al. (2007) tested the susceptibility of seventy E. coli isolates from humans and environments samples to 10 different antimicrobial agents by the diffusion method and reported that, resistant was found in 61.2% of the isolates. They observed that the most prevalent resistances were kanamycin and tetracycline (81.4%), followed by chloramphenicol (75.7%), gentamicin (74.3%), ampicillin (72.5%), nalidixic acid (66.6%) and sulfamethoxazole-trimethoprim (62.9%). The low prevalent were cefotixin (44.3%), norfloxacin (27.1%) and ciprofloxacin (24.3%). Their aim was to generate a baseline data on the prevalence of antimicrobial resistance in Escherichia coli isolates from different sources in Malaysia.

Lim et al. (2009) examined forty-seven E. coli isolates from various public hospitals in Malaysia and reported percentage resistances to the following antibiotics: ampicillin 77%, piperacillin 64%, tetracycline 53%, trimethoprim-sulfamethoxazole 43%, cefoperazone 30%, kanamycin 30%, nalidixic acid 28%, chloramphenicol 26%, ciprofloxacin 23%, gentamicin 21%, amoxicillin-clavulanic acid 17%, ceftriaxone 11%, ceftazidime 11%, aztreonam 11% and amikacin 2%. All the 47 isolates were sensitive to imipenem. Furthermore, 36 isolates (76.5%) were resistant to two or more antibiotics (multidrug-resistant).

Sukhumungoon et al. (2011) reported the percentage resistant of E. coli O571:H7 isolated from beef samples to be 38.5% (5/13) against four different antibiotics. One each of the isolate was resistant to cephalothin, ceftriaxone, cephalothin and ceftriaxone, ampicillin and ceftriaxone, cephalothin, ampicillin and amikacin and cefapodoxime, ceftriaxone and ampicillin.

Sahilah (1997) tested 65 strains of E. coli for their susceptibility against antimicrobials and reported that all the strains were resistant to four or more antimicrobial agent tested. The 65 strains were all resistant to bacitracin (100%), methicillin (100%) and vancomycin (100%) but susceptible to cephalosporin (100%), kanamycin (100%), nalidixic acid (100%) and furazolidone (100%).

**CONCLUSION**

In Malaysia few published data is available on the prevalence of E. coli and it resistance to antibiotics. The few published data revealed the presence of pathogenic E. coli strains and it resistance to multiple antibiotics. Most studies also concentrated on beef samples. A number of food poisonings have been reported in Malaysia of which pathogenic E. coli could be one of the possible causes although data available does not linked specific organisms to reported cases of food.
poisonings. Education of food handlers in improving their hygienic standard is very essential to reduce the risk of food-borne illnesses, diseases or poisonings.

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REFERENCES


