

Chapter 1

Introduction

1.1 Background

For several decades, antibiotic resistance has been a growing threat to the effective treatment of infectious diseases caused by bacteria. This problem has raised scientists' attention due to its adverse impacts on public health. By 2050, the antibiotic resistance is predicted to be the leading cause of death globally (O'Neill, 2016).

European Centre for Disease Prevention and Control (ECDC, 2009) conveyed that antibiotic resistances are responsible for severe infections in human. Based on the estimation, more than 25,000 people die annually due to multidrug-resistant bacteria (Public Health England (PHE), 2016). Moreover, Extended-Spectrum β -lactamases (ESBLs)-producing *Enterobacteriaceae* is a particular concern (Leonard *et al.*, 2015).

It has been further stated that 15,183 cases of bacteremia are caused by resistant-*E. coli*, one of the organisms belong to *Enterobacteriaceae* (PHE, 2016). The organism is also associated with 2,712 excess deaths and 120,065 excess hospital days (PHE, 2016). Furthermore, a study conducted by ECDC (2016) stated that 58.6% of the isolated *E. coli* were reported to be resistance to at least one of the antimicrobial groups, including third-generation of cephalosporins with a percentage of 12.4%. It is worrying as the resistant bacteria may be transmitted to other humans.

The transmission of antibiotic-resistant bacteria (ARBs) may have happened through human activities in bathing waters (recreational waters). Leonard *et al.* (2015) stated that there are three transmission routes of ARBs to humans: person-to-person contact, the ingestion of contaminated drinking water, and the natural environment. Natural environments, including soils and surface

waters, are well-known to be the reservoir of clinically important ARBs (Martinez, 2009; Ashbolt *et al.*, 2013; Finley *et al.*, 2013; Leonard *et al.*, 2015; Huijbers *et al.*, 2015).

Moreover, based on surveillance data from the United States of America, there were 24 recreational water diseases outbreaks related to direct contact with natural water (Fewtrell & Kay, 2015). While in the UK, the outbreaks related to swimming events are reported in rates between 31% and 85% (Fewtrell & Kay, 2015).

Portobello West beach, designated for bathing water in Edinburgh, becomes a particular concern. Based on water quality classification by Scottish Environment Protection Agency (SEPA, 2017), the classification of Portobello West beach is poor. Although no diseases outbreaks or cases related to water activities are found or reported, it is still concerned that the bathing water users may freely be exposed to the ARBs due to their low water qualities. Notably, this becomes a burden considering its popularity among families and dog walkers (SEPA, 2016b).

1.2 Objectives

Therefore, it is worth and interesting to investigate further about resistant-*E. coli* in bathing water, especially number of resistant-*E. coli* presented as well as the diversity of the *E. coli* in Portobello West beach. *E. coli*, a key mandatory microbial parameter for water quality assessment, was isolated to know the prevalence of resistant-*E. coli* (Rizzo *et al.*, 2013; SEPA, 2016a; US EPA, 2012; Wilson *et al.*, 2016). Furthermore, their susceptibility toward multiple classes of antibiotics, phylogroup, type of ESBL gene carried, as well as the type of ESL was identified to know the diversity of *E. coli*.