CHAPTER 1

INTRODUCTION

1.1 Background

Throughout the years, pathogen infections have perpetually been the most common cause of death worldwide. In 2010, 15 million people died from pathogen infections which decreased by only a million compared to 20 years ago (Dye, 2014). The death has concretely transpired in developing countries (Zhang et al., 2015). Several pathogen infections such as tuberculosis, diarrheal diseases, respiratory infections, HIV/AIDS, and malaria had contributed to the mortality of most population (Dye, 2014). In Indonesia, seven percent of the population died due to tuberculosis, followed by diarrheal diseases and lower respiratory infections which caused four percent and three percent of death, respectively (The Centers for Disease Control and Prevention (CDC), 2013).

High population number with poor hygiene and inadequate healthcare facilities made pathogen infections even more alarming in developing countries (Dye, 2014). In the remote areas of Indonesia, healthcare facilities are still far from sufficient (Coker, Hunter, Rudge, Liverani, & Hanvoravongchai, 2011) that the residents become less cautious of their health. Furthermore, most of developing countries are tropical (having the hot and humid condition). It is valuable for pathogens to grow and spread out. The intensity of growth is even higher nowadays due to climate change (Walsh, 2013).

In surmounting the spread of pathogen infections, treatments used are mostly commercial antimicrobial drugs. However, they have measurable side effects (Chandel & Budinger, 2013) and may impact patients in injurious manners (Barnhill, Brewer, & Carlson, 2012). Pathogens could also exhibit resistance traits toward the drugs due to indiscriminate usage (Mickienė et al., 2012). Additionally, a new generation of drugs against bacterial infection (antibiotics) are less accessible and have high prices in most of developing countries (Zhang et al., 2015). Due to these drawbacks, a large population of the

world starts relying on herbal medicines as an alternative treatment (Bokhari, Perveen, Al Khulaifi, Kumar, & Siddiqui et al. 2016).

As reported by World Health Organization (WHO), over 80% of populations in developing countries already took advantage of medicinal plants as a source of treatment (Kayalvizhi & Anthony, 2011). An extract of the plants is known to have abundant bioactive compounds with fewer side effects compared to commercial antimicrobial drugs (Johnson, Wesely, Kavitha, & Uma, 2011). Global researchers have also proven that extract from different parts of plants, including stem, root, flower, barks, leaves, etc. possess antimicrobial property (Johnson et al., 2011).

Mentha arvensis L. has attracted much interest in in the research world due to its frequent occurrence as well as several biological activities including antimicrobial properties and cytotoxic activities (Bokhari et al., 2016). This plant has also been used for years as traditional medicine (Abbaszadeh, Aliabadi Farahani, Alireza Valadabadi, & Moaveni, 2009; Biswas, Saha, & Ali, 2014). Ethanol extract and essential oil of *Mentha arvensis* L. are discovered to possess antimicrobial properties against pathogenic bacteria such as *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Bacillus subtilis*, *Shigella flexneri*, and *Streptococcus pyogenes* (Mickienė et al., 2012; Zhang et al., 2015). Nonetheless, a comparison of ethanol extract and essential oil against pathogenic bacteria still needs to be explored. Therefore, the present study intended to investigate antibacterial activity of ethanol extract and essential oil extracted from *Mentha arvensis* L. and chemical compounds contained.

1.2 Research Objectives

The study aims:

1. To investigate antimicrobial activity of ethanol extract and essential oil of *Mentha arvensis* L. against pathogenic bacteria and determine the optimum concentrations.
2. To investigate chemical compounds contained in ethanol extract and essential oil of *Mentha arvensis* L.