CHAPTER 1

INTRODUCTION

1.1 Background

According to the latest WHO and UNICEF (2017) report on progress on drinking water, sanitation and hygiene, 59 million people collects drinking water directly from surface water sources. A considerable proportion (18%) of Indonesian households rely on surface water sources, such as springs, rivers, ponds and lakes for their drinking water, which are prone to contamination problems (Statistics Indonesia, 2014). This shows that drinking water may expose citizens of Indonesia to dangerous disease-causing bacteria like pathogenic *Escherichia coli* (*E. coli*) and many more, thus causing endemics of disease such as diarrhoea and others.

Drinking water, which is water that has gone through or has not gone through processing that meets the health standard and can be directly drunk (Keputusan Menteri Kesehatan Nomor 492, 2010), is considered safe for consumption if it meets the physical, microbiological, chemical, and radiological parameters. An example of the microbiological parameter that should be met is the amount of *E. coli* found per 100ml of sample, in which the number should not exceed 0. *E. coli* is chosen as a parameter as it is a faecal coliform, in which when present, it signifies drinking water is contaminated with faecal particles. Not only that, some strains of *E. coli* are particularly pathogenic (Permenkes No 492 Tahun 2010).

Various methods of drinking water disinfection from harmful bacteria are utilised by people from all over the world, including Indonesia. Most countries rely on using ultraviolet (UV) for inactivating bacteria such as *E. coli* in drinking water, with some

using UV lamps in their water systems (Kepmenperindag, 2004), and others utilising the naturally occurring sun rays with the help of small-scaled solar disinfection (SODIS) appliances, in which drinking water is stored in clear PET bottles or pipes and then subjected to sunlight for 6 hours when sunny or 2-3 days when cloudy , especially in areas with stronger sunlight. Nowadays, novel methods that either incorporates UV disinfection into their instrument or does not use UV in their disinfection methods are emerging. Example of such novel instruments that combines UV with other disinfection methods is TiO_2 photoreactor, and that of Non-UV methods is reactive electrochemical membrane (REM). These instruments aim to give an end result of drinking water that contains 0 CFU/mL of *E. coli.*

But drinking water obtained do not always meet the standard given by the government, potentially giving way for coliforms and bacteria to present in the drinking water. This means that harmful bacteria such as *E. coli* that may be found in the filtered water are not exposed to heat, thus the bacteria are not killed and stays in the filtered water, waiting to be consumed. As an example, in 2017 Ministry of Health took samples of filtered water from DAMs found in Tulungagung, and 30% of the filtered water samples had *E. coli*, whereas indicator for safe drinking water is the presence of 0 *E. coli*. Because of this, there is a potential that a health problem will persist in the community or district because of the presence of harmful components found in the filtered water.

This systematic review presents and discusses published data from the literature, aiming to give an analysis of the evidence of the efficacy of UV disinfection and other methods of water disinfection, both combination of UV with other methods and non-UV methods when it comes to disinfecting different sources of drinking water with

different concentrations of *E. coli* present in the water. Author also wishes to find which method yields the best result, and which method is applicable for use in Indonesia, either in city settings or rural areas that lack access to proper electricity sources and advanced materials. To the best of the authors' knowledge, this is the first systematic review paper on the application of UV and other novel methods for water disinfection.

1.2 Research Question

Is UV disinfection more effective compared to other novel disinfection methods; UV combined with other methods and non-UV methods, in the inactivation of *E. coli* present in drinking water?

1.3 Research Objective

1.3.1 General Objective

To find the effectivity of UV disinfection compared to other novel disinfection methods in the inactivation of *E. coli* present in drinking water.

1.3.2 Specific Objective

1. To see whether UV only with LED apparatus is more effective than UV only with SODIS in the inactivation of *E. coli* present in drinking water.
2. To see whether UV only method in general is more effective than UV combined with other methods in the inactivation of *E. coli* present in drinking water.
3. To see whether UV only method in general is more effective than other non-UV water disinfection methods in the inactivation of *E. coli* present in drinking water.

1.4 Research Benefit

1.4.1 Theoretical Benefits

To provide summary on the type of water treatment disinfectant(s) (UV only, UV combined with other methods and other novel methods) that can be used in order to yield drinking water with the best quality in terms of microbiology (number of *E. coli* left in drinking water).

1.4.2 Practical Benefits

1. To help citizens of Surabaya and other parts of Indonesia decide on what method of drinking water disinfection they want to implement in cases where they are not able to obtain safe and certified drinkable water.

2. To help small scale drinking water producers (mineral water producers, Water Depos) in Indonesia decide on what method of drinking water disinfection to use to produce drinking water with the most ideal qualities.

3. To improve understanding of how different kinds of water treatment disinfectants may impact the microbiological components of the water, especially *E. coli* count.