CHAPTER I

INTRODUCTION

1.1 Background

An upper respiratory tract infection (URTI) is a contagious infection of the upper respiratory tract, which includes the nose, sinuses, pharynx, and larynx. Among the most common URTIs include acute bronchitis, the common cold, influenza, laryngitis, pharyngitis, and respiratory distress syndromes. These are often transmitted through airborne respiratory droplets (from sneezing or coughing), skin-to-skin contact, or by touching a contaminated surface. According to Zhou and Li (2015), *Streptococcus pyogenes* and *Pseudomonas aeruginosa* are among the most common URTI-causing bacteria.

Recently, efforts have been made to reduce or manage the prevalence of URTIs through traditional medicine. Various plant-based treatments options have since been proposed in previous studies as an alternative to conventional medicine to treat URTIs, such as the use of fingerroot (*Boesenbergia pandurata*), tiwai onion (*Eleutherine americana*), and rose myrtle (*Rhodomyrtus tomentosa*) extracts against *S. pyogenes* (Limsuwan and Voravuthikunchai, 2013). Extracts from horseradish (*Armoraciae rusticanae*) root and nasturtium plants have also shown antibacterial efficacy against *P. aeruginosa* (Conrad *et al*., 2006).

Guava (*Psidium guajava* L.) leaves have been used traditionally in many countries to manage various diseases and infections. Pharmacological research (both *in vivo* and *in vitro*) have been widely used to demonstrate the potential of guava leaf extract for the co-treatment of various ailments of high prevalence

worldwide, including cardiovascular diseases, diabetes mellitus, cancer, and parasitic infections (Biswas *et al*., 2013; Mohammed and Taha, 2017; Ghosh *et al*., 2010). Previous studies have also shown the antibacterial efficacy of guava leaves against pathogenic bacteria such as *Staphylococcus aureus* and *Bacillus cereus* (Biswas *et al*., 2013); *Streptococcus mutans*, *Escherichia coli*, and *Salmonella enteritidis* (Dhiman *et al*., 2011); *V. parahaemolyticus* (Farjana *et al*., 2014), and *Aeromonas hydrophila* (Mahfuzul *et al*., 2007). According to Ugoh and Nneji (2013), the strong bactericidal activity exhibited by guava leaves may be due to its protein-degrading activity, although the degree to which this is present relies on the method of extraction. This is because different factors during extraction such as solvent used affect the number and types of bactericidal compounds present in the final extract as these compounds may vary widely in terms of polarity.

Despite established evidence of their pharmacological efficacy, plant extracts are often unpalatable and do not elicit good responses in terms of other sensorial properties such as texture and mouthfeel. This makes extract-infused sugar confectionery such as hard candy an appealing product to encourage extract intake. Hard candies are an attractive option as the high sugar content greatly enhances flavor and palatability, while the hard, brittle glass structure allows the consumer to savor the product for a long period of time during consumption (Hartel *et al*., 2018).

Additional flavoring is often incorporated into candy formulation in the form of extracts, essential oils, or organic acids to enhance consumer appeal and product value. Certain plant extracts may be used as flavoring agents due their unique flavor

profile, which can be used to either mask unpalatable flavors in the candy or to enhance its overall flavor profile (Hartel *et al*., 2018).

Lemongrass (*Cymbopogon citratus*) is often described to impart a flavor reminiscent of lemon and lemon mint, with subtle ginger-like notes. When used as a flavoring agent, it imparts a slightly sharp and tangy taste, as well as a very fragrant grassy lemon-like aroma (Charles, 2012). Lemongrass can be used as a flavoring agent in sugar confectioneries such as hard candy in the form of essential oils or extracts (Natisri *et al*., 2014). A hard candy with antibacterial benefits can therefore be developed by infusing it with guava leaf extract, which possesses antibacterial properties, and lemongrass, which can enhance the overall flavor of the candy.

1.2 Research Problem

Previous studies have demonstrated that guava leaf extract may impart antibacterial benefits upon ingestion (Biswas *et al*., 2013; Dhiman *et al*., 2011). Because of this antibacterial activity, it may be used therapeutically for those with or are at risk of an upper respiratory tract infection (URTI) caused by *Streptococcus pyogenes* and *Pseudomonas aeruginosa*. Formulating guava leaf extract into hard candy may offer antibacterial benefits for those with URTI in a manner that is both palatable and easy to consume, as plant extracts generally have an unpleasant taste and mouthfeel when consumed alone. However, due to differences in polarity, certain antibacterial compounds may only be present in significant amounts when extracted with a solvent of similar polarity; the best type of solvent with which to extract guava leaves for its antibacterial properties against pathogenic URTI

bacteria therefore needs to be studied. Additionally, the sensory properties and acceptability of the hard candy must also be evaluated to determine the best concentration with which to use lemongrass oil as a flavoring agent.

1.3 Objectives

1.3.1 General Objectives

The general objective of this study was to incorporate guava leaf extract into hard candy as its primary functional ingredient and lemongrass oil as the flavoring agent, and to determine its antibacterial activity against upper respiratory tract infection (URTI) bacteria.

1.3.2 Specific Objectives

The specific objectives of this study were as follows:

1. To determine the best solvent for guava leaf extraction by measuring the antibacterial activity against *S. pyogenes* and *P. aeruginosa* based on its minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC).
2. To determine the best concentration at which the selected solvent extract is formulated into the hard candy by evaluating the antibacterial efficacy and sensory characteristics of each hard candy formulation.
3. To determine the effect of guava leaf extract and lemongrass oil concentrations on the physical characteristics (color and texture) and sensory characteristics of the hard candy.