CHAPTER 1

INTRODUCTION

1.1 Project Background

Skin is part of the human body that acts as the primary barrier against environmental injury and an injury to the skin results in wound, initiating a process called wound healing. Wound healing process is an important biological process that consists of a few phases such homeostasis, inflammation, cellular migration and proliferation, and protein synthesis (Dreifke et al., 2015). During the wound healing step, proliferation phase, a network of connective tissue will form, causing granulation of tissue which allows reconstruction of the skin (Gonzalez et al., 2016). Wound healing proces can be improved by choosing a suitable material that can help to prevent any further infection, resulting in a better remodelling of the skin tissue. Ideally, the characteristics of an ideal wound dressing are high absorption capacity, high moisture permeability, good adhesion to the surrounding skin, and non- adherent (Ilenghoven et al., 2017).

As the wound healing industries are increasing, the use of natural materials as an alternative material for wound dressing becomes an interest to scientists. Natural polymers have a more advantages than synthetic polymers due to good biocompatibility (Minhas et al., 2016). As of recently, keratin has received increased interest due to its ability in self-assembly. Keratin can assist in cell attachment and support the proliferation as well as extracellular matrix production, thus making it possible to be used as an alternative wound dressing. In addition, keratin also has antimicrobial properties against E. coli and S. aureus which are the most common bacteria found in wound infection (Sundaram & Banu, 2015).

One of the most common materials that contain keratin is human hair which is abundant, making it possible to be utilized as autologous biomaterial. Incorporating keratin with other materials can allow the improvement of its mechanical strength. Pectin is one of the most common materials that is used in

combination with other polymers as wound dressing (Mir et al., 2018). Pectin is a polysaccharide that is usually derived from natural plant that are usually used in healthcare, food, or cosmetic industries and mainly contain d- galacturonic acid units, though the exact chemical composition and the structure are not well established due to its complexity on the number of hydroxyl and carboxyl group (Minzanova et al., 2018). The chemical structure of pectin may vary due to its extraction process, environmental factor and depending on the condition of the plants itself (Lara-Esipinoza et al., 2018). In addition, pectin contains several beneficial properties due to its ability in absorbing exudates, sustaining acid environment, and potential antibacterial properties (Munarin et al., 2012). A study conducted by Mishra et al. (2011) showed that a combination of pectin and gelatin hydrogel resulted in a successful application in moist wound dressing application. Other than the addition of pectin to improve wound healing process, the addition of antibiotics can also help to prevent any further infection of the wound, possibly via improving the antimicrobial properties of the wound dressing, improving the stability, the delivery and the release of the antibiotics, which lead to the optimal effect of the antibiotics (Norman et al., 2016).

There are various antibacterial agents that can boost the wound healing properties such as antibiotics, silver-based dressings, iodine, and honey-based dressing. The main goal of encapsulating drug or antibacterial materials with a polymer is to reduce the frequent consumption of the drug because it will be released over a prolonged time and to directly work on the site of infection.

Great attention has been given to hydrogel-based polymer which will provide not only crosslinking without the addition of toxic photo cross linkers but also improving its physical characteristics (Van Tomme et al., 2008). This hydrogel-based polymer via ionic gelation can be used as potential carriers in controlled drug delivery which can offer an inert environment within the matrix. The moist environment is a very important factor for the wound healing process because it can help the epithelium cells to migrate (Giusto et al., 2017). Ionic or ionotropic gelation is based on the crosslinking abilities of the polyelectrolytes in the

presence of an ion to form hydrogels. This method is chosen due to its simplicity and is a well-known method for encapsulation of a drug in polymers (Thadanki, 2017).

Although keratins have been fabricated into many forms such as hydrogels, fibers, and films (Rouse & Van Dyke, 2010), none has been reported about keratin and pectin hydrogel in combination with antibacterial materials. In this present study, a wound dressing matrix in a form of hydrogel consisting of pectin, keratin, and antibacterial agents will be fabricated. The keratin will be extracted from human hair and then later be combined with pectin and antibacterial agent that will form a cross- linked matrix using ionic gelation method by addition of cation in a form of $CaCl_2$.

1.2 Research Objectives

Objective of this research is listed below:

- To fabricate hydrogel from human hair keratin and pectin incorporated with antibacterial agents that have good physicochemical and antibacterial properties

1.3 Research Hypothesis

The pectin- keratin hydrogel will be able to exert improved physico-mechanical characteristics of the composite compared to the material on its own. Additionally, the addition of antibacterial material will successfully be delivered and exhibit improved antibacterial properties compared to blank composites.

1.4 Research Scope

This study will focus on ionic gelation fabrication method to form pectin keratin embedded with antibacterial agent hydrogel. Specifically, the scope of work that would be employed in this study include:

- Keratin Extraction and Characterization from human hair using Shindai's method
- Fabrication of keratin-pectin hydrogel incorporated with antibacterial agent using ionic gelation
- Physical characterization of hydrogel by FTIR analysis, drug release study, swelling study and erosion study
- Antimicrobial activity measurement of hydrogel towards *E. coli* and *S. aureus*