# UNIVERSITI TEKNOLOGI MARA

# EFFECTS OF ELECTROSPINNING PARAMETERS ON CARRAGEENAN-BASED NANOFIBERS FABRICATION

**DAYANGKU ELMA RASHIDAH BINTI RASHID**

Thesis submitted in partial fulfillment
of the requirements for the degree of
**Bachelor of Engineering (Hons)**
**Chemical**

**Faculty of Chemical Engineering**

**July 2019**

# ABSTRACT

Polymer nanofibers are known to exhibits excellent properties that made it very useful in producing and development of tissue engineering, filtration, biochemical engineering and many more. Nowadays, electrospinning is the most commonly and preferably used to manufacture these polymer nanofibers because the nanofibers produced using this technique ably to produce a high surface area to volume ratio. Carrageenan-based nanofibers were prepared by electrospinning of polyvinyl alcohol (PVA)/carrageenan (CAR) solution. The solution is made of 1 w/v% of CAR solution and 13 w/v% fully hydrolyzed PVA solution. The solutions were mixed with a ratio of 70:30, creating the polymer solution, FH PVA/CAR solution. The morphology and diameters of the nanofibers were observed by using a scanning electron microscope (SEM), the contact angles on the nanomembrane were measured by static micro-drop observation, and the effects of electrospinning parameters including voltage, distance between tip of needle and collector, as well as the flow rate of the solution were observed. The study was carried in a series of experiments involving different voltages, flow rate and tip to collector distance. The different voltages include 9kV, 12kV, 15kV and 18kV where the average diameter is observed to be increasing from 160.94 nm, 137.95 nm, 128.18 nm, to 119.69 nm, respectively. This shows that by increasing applied voltage, the fiber diameter decreased. it is also observed that the mean fiber diameter is 129.52 nm, 133.85 nm, 138.73 nm, and 140.49 nm, accordance with the flow rates 0.2 ml/h, 0.3 ml/h, 0.4 ml/h, and 0.5 ml/h. this implies that increment of flow rate causes the increment of fiber diameter. On the other hand, the effect of increasing tip-collector distance from 12cm, 15cm, 18cm, to 21cm resulted in decreasing of fiber diameter that is 132.94 nm, 131.79 nm, 124.38 nm, and 114.72 nm, respectively. Contact angle of the electrospun nanofibers decreases over time to below 90°, showing that the nanofibers is hydrophilic. This study is helpful to optimize the electrospinning process parameters for the preparation of PVA/CAR nanofibers whether according to desired mean diameter.

# ACKNOWLEDGEMENT

First and foremost, I wish to thank God for giving me the opportunity to embark on my degree and for completing this long and challenging journey successfully. I would also like to thank my research supervisors, Mr. Abdul Aziz ishak, and Dr. Noor Fitrah Abu Bakar. Without their assistance and dedicated involvement in every step throughout the process, this paper would have never been accomplished. I would like to thank you very much for your support and understanding.

My appreciation goes to Universiti Teknologi MARA whom provided facilities and assistance during sampling. Special thanks to my colleagues and friends for helping me with this project.

Most importantly, none of this could have happened without my family. To my parents and my siblings– it would be an understatement to say that, as a family, I thank you very much for your non-stop supports and du'a, unconditional love and encouragement that I will always remember for the rest of my life.

# TABLE OF CONTENTS

**Page**

# CHAPTER ONE
# INTODUCTION

## 1.1 Research Background

Carrageenan (CAR) is a species of seaweed that is belonged to the marine red algae family. It is considered to be the most appealing out of the other sources of the polysaccharides, with different type of structures and functional properties, CAR is known to own gel-forming ability, biocompatibility, abundance and renewability (Roy, Shankar, & Rhim, 2019). Carrageenan can be categorized in to six different basic forms which are Kappa (κ)-, Lota (ι)-, Lambda (λ)-, Mu (μ)-, Nu (ν)-, and Theta (θ)-carrageenan (L. Li, Ni, Shao, & Mao, 2014). They are classified accordingly to the degree of substitution that occurs on their free hydroxyl groups (Goonoo et al., 2017). (κ)-, (ι)-, and (λ)-carrageenan are known to be the most important forms out of the basic forms of carrageenan commercially due to their viscoelastic and gelling properties (Goonoo et al., 2017). (κ)-carrageenan has only one negative charge per disaccharide with a tendency of forming a strong rigid gel (S. Y. Park, Lee, Jung, & Park, 2001). The carrageenan that will be used in this study is (κ)-carrageenan. Carrageenan is commonly used as thickening, emulsifying and also its stabilizing agent usually used in the food and pharmaceutical administration as well as industrial applications (Bener, Şen, Kaşgöz, & Apak, 2018). CAR is also used in tableting excipients due to its great compatibility, high robustness and persistent viscoelasticity of the tablet during compression (Campo, Kawano, Silva, & Carvalho, 2009)It is also known that carrageenan have the potential of having the properties of anticoagulant, anticancer and modification on the immune system which may be very important in the pharmaceutical industry (S. Y. Park et al., 2001).

Polyvinyl Alcohol (PVA) is known to be a water-soluble, hydrophilic semi-crystalline, and non-toxic synthetic polymer, widely used in the production of films and fibers as well as the applications in filtration and biochemical engineering (J.-C. Park et al., 2010). This is due to its amazing chemical stability, mechanical and physical properties (C. Zhang, Yuan, Wu, Han, & Sheng, 2005). PVA is one of the most highly biocompatible and non-toxic polymers making it a widely used polymer in film forming, electrospinning antimicrobial nanofibrous mat to be used in different applications, such as medical, cosmetic, food, pharmaceutical, and