THE EFFECT OF DIFFERENT DRYING METHODS ON THE QUALITY CHARACTERISTICS OF *KAPPAPHYCUS ALVAREZII SP.* SEAWEED POWDER

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Submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for Bachelor Degree of Manufacturing Engineering (Hons.)

by

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DECLARATION

I hereby, declared this report entitled "The Effect of Different Drying Methods on The Quality Characteristics of *Kappaphycus alvarezii sp.* Seaweed Powder" is the results of my own research except as cited in references.

Signature : .....

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APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of Universiti Teknikal Malaysia Melaka as a partial fulfilment of the requirement for Degree of Manufacturing Engineering (Hons). The member of the supervisory committee is as follow:

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ABSTRAK

Kaedah pengeringan memainkan peranan penting dalam mengekalkan nutrien semula jadi dalam rumpai laut. Penyelidikan ini bertujuan untuk menentukan jangka masa optimum untuk kaedah pengeringan ketuhar berdasarkan kualiti *Kappaphycus alvarezii sp.* serbuk rumput laut. Untuk memberikan pengeringan yang baik, ia tidak boleh menghilangkan kandungan mineral dalam *Kappaphycus alvarezii sp.* selepas pengeringan rawatan kerana mineral bertindak menjaga kualiti makanan. Walau bagaimanapun, kajian sebelumnya menunjukkan bahawa kandungan mineral dalam rumpai laut banyak hilang setelah rawatan pengeringan melalui kaedah pengeringan matahari. Kaedah pengeringan matahari menyebabkan tempoh pengeringan yang lama kerana suhu yang tidak menentu. Oleh itu, pengeringan ketuhar boleh menjadi penyelesaian kerana dapat mengurangkan jangka masa pengeringan kerana melibatkan suhu tertentu, tetap dan konsisten. Oleh kerana itu, ia dapat mengelakkan pencemaran luar yang tidak diingini yang dapat menghilangkan komponen kimia penting tertentu. Walaupun begitu hingga kini, kajian yang terhad dilakukan terhadap rumpai laut *Kappaphycus alvarezii sp.* melalui kaedah pengeringan ketuhar kerana banyak penyelidik memfokuskan pada kaedah konvensional, iaitu kaedah pengeringan matahari. Untuk memperoleh dan menganalisis kandungan kelembapan dan mineral untuk kedua kaedah pengeringan berdasarkan parameter yang telah ditetapkan, analisis kandungan kelembapan dan analisis mineral telah dipilih. Tempoh pengeringan optimum untuk kaedah pengeringan ketuhar adalah 10 jam kerana kandungan lembapan yang lebih rendah dan nilai kandungan mineral yang lebih tinggi. Selama 10 jam pengeringan ketuhar, rumpai laut dapat menjaga dan mengawal kehilangan kandungan mineral serta menurunkan kadar kelembapan untuk mengekalkan kualiti rumput laut Kappaphycus alvarezii sp. setelah melalui rawatan pengeringan. Oleh itu, pengguna akan mendapat faedah dari produk berasaskan rumput laut ini sekiranya kualiti rumpai laut dapat dikekalkan kerana nilai pemakanan tinggi rumpai laut menyumbang kepada nutrien manusia seperti vitamin, mineral dan semua asid amino penting.

ABSTRACT

Drying methods play a significant role in preserving the natural nutrients found in seaweed. This research aims to determine the optimum duration for oven-drying method based on the quality characteristics of *Kappaphycus alvarezii sp.* seaweed powder. In order to provide excellent drying behaviour, it should not eliminate the mineral content in *Kappaphycus alvarezii sp.* after drying treatment as minerals acts in maintaining the quality of the food. However, the previous studies show that the mineral contents in seaweed are heavily lost after the drying treatment by the conventional drying method, i.e., direct sun-drying method. Sun-drying method causes a long period of drying duration due to unpredictable and uncertain temperatures. Therefore, oven-drying may offer a solution as it can reduce the duration of drying since it utilizes a specific temperature, fixed and consistent. Moreover, it can avoid unwanted outside contamination which could possibly eliminate certain important chemical components. Nevertheless to date, there is a limited number of studies that have been done on the seaweed *Kappaphycus alvarezii sp.* using oven-drying method since many researchers still focusing on the conventional method, which is the sun-drying method. In order to obtain and analyze the moisture and mineral contents for both drying methods based on the parameter that has been set, the tools such as moisture content analysis and mineral analysis have been selected. The optimum drying duration for oven-drying method is 10 hours as it provides low moisture content and high mineral content values. At 10 hours of oven-drying, *Kappaphycus alvarezii sp.* seaweed is able to keep and control the loss of the mineral content while lower the moisture content to retain the quality of *Kappaphycus alvarezii sp.* seaweed after going through the drying treatment. Thus, consumers will get benefits from this seaweed-based products if the quality of seaweed can be retained as the high nutritional value of *Kappaphycus alvarezii sp.* contributes to human nutrients such as vitamins, minerals and all the essential amino acids.

DEDICATION

Only

my beloved father, Sulaiman bin Bachik

my appreciated mother, Nina Kurniawati binti A. Wahab

my sister, Nur Hasanah binti Sulaiman

my kindhearted supervisor, Ts. Dr. Rose Farahiyan binti Munawar

my friends

for giving me moral support, money, cooperation, encouragement and also understandings

Thank You So Much & Love You All Forever

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SEM	-	Scanning Electron Microscopy
ICP-AES	-	Inductively Coupled Plasma-Atomic Emission Spectrometry
EDX	-	Energy Dispersive X-Ray

LIST OF SYMBOLS

%	-	Percent
wt%	-	Weight Percent
°C	-	Degree Celsius
kg	-	Kilogram
mg/g DW	-	Milligram per gram of dry weight
mg mL^{-1}	-	Milligram per milliliter
nm	-	Nanometer
µm	-	Micrometer
cm	-	Centimeter
min	-	Minute
g	-	Gram
ml	-	Milliliter
mg/ml	-	Milligram per millilter
kV	-	Kilovolt
Ca	-	Calcium
Mg	-	Magnesium

CHAPTER 1
INTRODUCTION

1.0 Introduction

This chapter describes the background of the study, problem statement, objectives, research scopes and the significance of this research. The *Kappaphycus alvarezii sp.* seaweed was used throughout the study as a representative of the investigated seaweed species, as demanded by the respective industry (Saanen Sdn. Bhd.).

1.1 Background of Study

Seaweed or marine algae are a group of organisms that either lives in ocean or swamps waters. Similar to the land plants, seaweed contains photosynthesis pigmentation and photosynthesizes and produces food with the aid of sunlight and nutrients provided by the ocean water. Seaweeds are discovered between high to low tide in the coastal area and up to a level in the sub-tidal region whereby only 0.01% photosynthetic light is reachable. In order to create different circumstances, plant pigments, visibility, light, temperature, depth, tides and shore behaviours merge to specify the classification and variation of seaweed. Seaweed is essentially divided into three main categories, which including green (Chlorophyta), brown (Phaeophyta) and red (Rhodophyta) (Brownlee *et al.*, 2012). Seaweed is low in calories, high in fibre and minerals, and contain a substantial quantity of protein, vitamins and essential minerals. In addition, seaweeds are able to generate important oxidation immune defences. Seaweed is indeed an essential source of natural antioxidants which can protect the human body toward free radicals (Mohamed *et al.*, 2018).

In Malaysia, the most significant and widely cultivated seaweed species is *Kappaphycus alvarezii sp. Kappaphycus alvarezii sp.* is a red seaweed species (Rhodophyta) and can be found in reddish, yellowish, green and brown in colour based on the presence of the water-soluble pigments, the blue phycocyanin and red phycoerythrin pigments. (Rudke *et al.*, 2020). The red *Kappaphycus alvarezii sp.* seaweed is abundantly found in Semporna, Sabah. Resulting in the high market value of *Kappaphycus alvarezii sp.*, the seaweed variation from Sabah was relocated and cultivated in Langkawi and Kedah. The red *Kappaphycus alvarezii sp.* seaweed, commercially recognized as *Eucheuma cottonii* is an economically valuable tropical Rhodophyta that is highly sought after for its polysaccharide cell wall and carrageenan properties, making it the most important carrageenophyte for industrial purposes in the world (Ilias *et al.*, 2017). Over the last four decades, *Kappaphycus alvarezii* has become the most crucial element of kappacarrageenan, a vital source in different applications and products. Carrageenan is most often used in the food industry due to its functional and physical characteristics including such thickening, stabilizing, gelling, water-binding and texturing a range of dairy and instant items like ice cream, frozen desserts, chocolate, milk, yoghurt, cheese, pie, puddings and sauces.

The drying process is one of the most important post-harvest treatment of seaweed. The main priority of the drying process is to conserve and increase the lifespan of the seaweed. However, the drying process can also adversely affect seaweed based on certain factors such as drying temperature, drying conditions and drying period. It may lead to unwanted changes in the colour, quality, nutritional, phytochemical content and aroma of seaweed (Badmus *et al.*, 2019). The quality of the seaweed, such as mineral content value will deteriorate after undergoing a drying process. Besides, the conventional drying method, which is the sun-drying process, offers a more negative impact on the seaweed as it not only reduces the quality of the seaweed, it also caused the seaweed exposed to dirt and dust contamination, insect infestation, uncertain drying temperature (uncontrollable weather), direct exposure overheating and long drying duration (Maisnam *et al.*, 2017). After reading several previous research paper, the perfect and suitable alternative method to replace the conventional drying method is by conducting the oven-drying method. Besides counter all the problem facing by the conventional method, the oven-drying method also is the easiest drying method (Babu *et al.*, 2018).

Hence, the aim of this research study is to plan the preparation and characterization of *Kappaphycus alvarezii sp.* seaweed powder by using the different drying method, which is the sun-drying and oven-drying method based on the different drying duration. Due to the shortcomings of the previous study, the effect of oven-drying method on the *Kappaphycus alvarezii sp.* seaweed powder quality compare to the conventional method, which is sun-drying, with a complete characterization were analyzed and discussed. For both drying methods, the moisture content and mineral content after the formation of *Kappaphycus alvarezii sp.* seaweed powder have been further determined and evaluated using the moisture content analysis and mineral analysis. In addition, the surface morphology of the dried samples of *Kappaphycus alvarezii sp.* seaweed for both drying method also has been analyzed by using Scanning Electron Microscope.

1.2 Problem Statement

This study emphasises the preparation and the characterization of *Kappaphycus alvarezii sp.* seaweed powder on how different drying method, which are sun-drying and oven-drying method would affect the seaweed powder. Seaweed contains natural minerals and antioxidants which contribute significantly in retaining the quality of food as well as protecting the health of the body (Sehwag and Das, 2013). To produce a seaweed powder, there are several processes involved starting with the cleaning the seaweed, soaking process, cutting process, drying process and lastly is grinding process. Drying process is a major process that might affects the moisture content and mineral content in the seaweed.

There are several drawbacks on the drying process of seaweed using conventional methods, which is sun-drying method. In order to produce a quality seaweed powder, the quality characteristics such as minerals should be maintained as much as possible after going through the drying process. The sun-drying method is carried out in an open environment, which may degrade the quality of the food. It is due to exposure to contamination of dirt and dust, infestation of insects, direct overheating of exposure, long drying duration and low heat transmission rates (Naseer Ahmed *et al.,* 2013). In addition, sun-drying method offers the drying process using the sunlight. Meaning that this method relying 100% on the weather condition. Since the weather is uncontrollable, the

temperature could vary significantly and be unpredictable. This will lead the food to dry slowly and increase the risk of contaminating the food.

To provide high demand and huge potential market of *Kappaphycus alvarezii sp.* seaweed powder, it needs to maintain the quality of the seaweed powder as well as speed up the drying process. Therefore, to overcome the limitations of conventional drying method, the method of oven-drying was conducted in this study. By conducting oven-drying method, many problems encountered during the implementation of the sun drying process can be fixed. Oven-drying method offer fixed and consistent temperature, short duration of drying and protect seaweed from outside contamination. Moreover, based on Çoklar and Akbulu's (2017) study on black grapes, oven-dried sample indicates a lower loss of antioxidant activity compared to sun-dried sample. It follows that the minerals will exhibit the same results. In fact, some of the antioxidants are minerals as well such as zinc, copper and manganese (Muhammad *et al.*, 2012). Other than that, fixed and higher temperature of oven-drying will provide faster duration to achieve the suitable moisture content. With low mineral content loss and quickly to achieve perfect moisture content, oven-drying method will produce the higher quality of *Kappaphycus alvarezii sp.* seaweed powder compared to sun-drying method. Figure 1.1 shows the summarization of problem statement and research gap of seaweed powder.

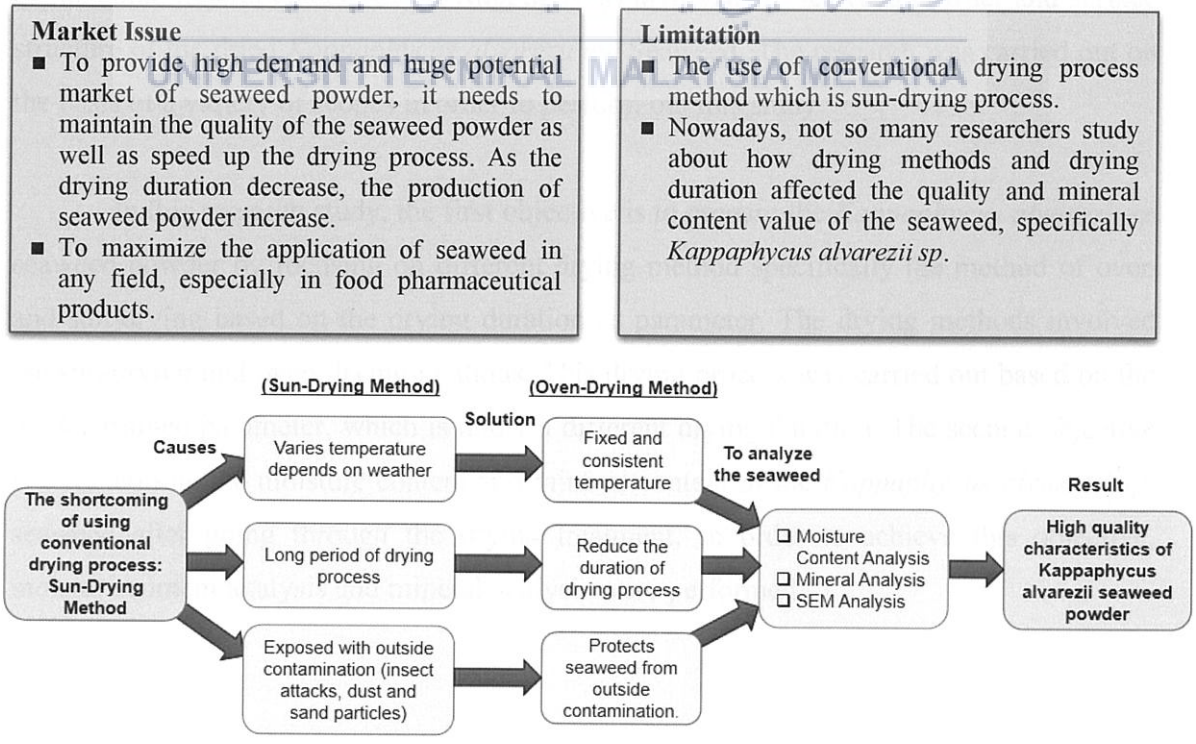

Figure 1.1: The summarization of problem statement and research gap

1.3 Objectives

1. To prepare the *Kappaphycus alvarezii sp.* seaweed powder by focusing on different drying method specifically the method of oven and sun-drying based on the drying duration as parameter.
2. To determine the moisture content and mineral content of the *Kappaphycus alvarezii sp.* seaweed after drying treatment using Moisture Content Analysis and Mineral Analysis.
3. To characterize the surface morphology and structure of *Kappaphycus alvarezii sp.* seaweed by using Scanning Electron Microscopy (SEM) Analysis.

1.4 Research Scopes

This study concentrates on the drying process of *Kappaphycus alvarezii sp.* seaweed in order to form the seaweed powder by utilizing different drying methods based on the drying duration to investigate the effect of drying process on the quality of the seaweed powder. The main purpose is to determine the optimum duration for the oven-drying method in order to replace the sun-drying method based on the moisture content and mineral content of the *Kappaphycus alvarezii sp.* seaweed powder and surface structure of the dried *Kappaphycus alvarezii sp.* Seaweed. The research was carried out on the basis of a variety of scopes in order to perform out this study.

In this research study, the first objective is to prepare the *Kappaphycus alvarezii sp.* seaweed powder by focusing on different drying method specifically the method of oven and sun-drying based on the drying duration as parameter. The drying methods involved are sun-drying and oven-drying methods. This drying process was carried out based on the predetermined parameter, which is under a different drying duration. The second objective is to determine the moisture content and mineral content of the *Kappaphycus alvarezii sp.* seaweed after going through the drying treatment. In order to achieve this objective, moisture content analysis and mineral analysis were performed.

The purpose of doing moisture content analysis is to study the amount of water in *Kappaphycus alvarezii sp.* seaweed powder after going through all the processes in the formation of seaweed powder. Mineral analysis is to study the mineral content value that remain in the seaweed powder after going through the processes to form the seaweed powder. However, due to Covid19's pandemic constraint, the mineral analysis study was conducted through postulating the critical review analysis. The last objective is to characterize the surface morphology and structure of the *Kappaphycus alvarezii sp.* seaweed. To accomplish this final objective, Scanning Electron Microscopy (SEM) analysis was performed to study the surface morphology and structure of *Kappaphycus alvarezii sp.* seaweed after the drying process. Figure 1.2 shows the mapping matrix for the scopes and objectives.

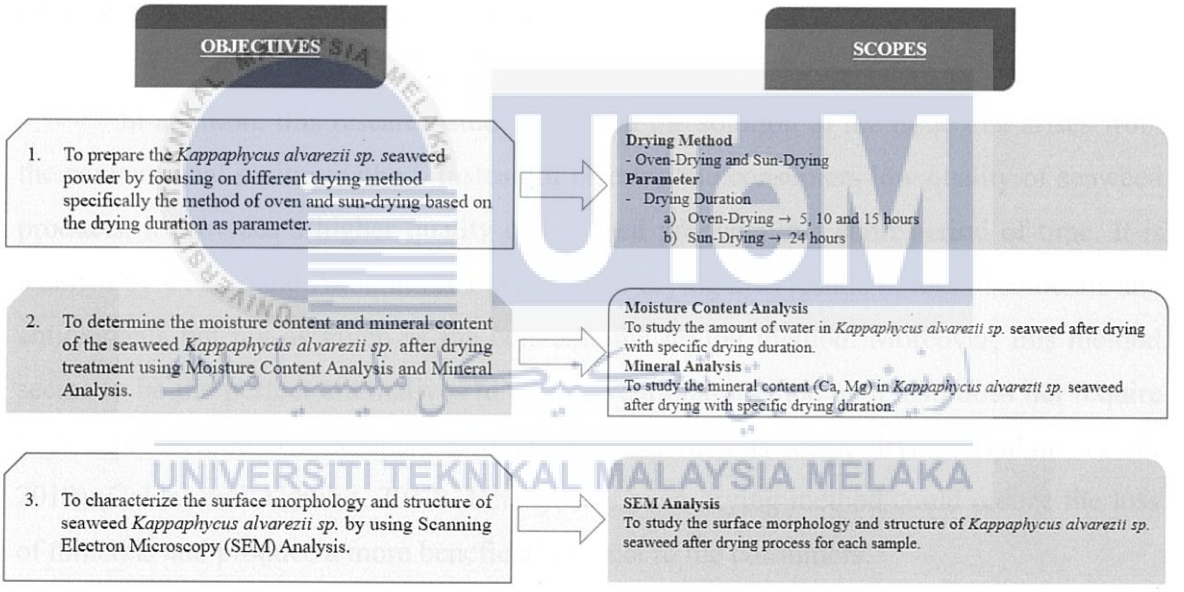

Figure 1.2: The mapping matrix of the scopes and objectives

1.5 Significant of Research

Seaweed has a high nutritional value such as protein, vitamin and mineral content that can be beneficial to the human body. Apart from using it in human products, seaweed has also been used in pet food due to its high mineral and nutritional value. (Kumar *et al.*, 2014). Minerals are elements of chemical that are needed for proper metabolic activity. Some minerals are required by human's body system to work effectively, and they can