PROTEIN EXTRACTION OF LOCUST (*LOCUSTA MIGRATORIA*) VIA ACID METHOD

by

NURUL HAZIQAH BINTI KHAIRUL AFFENDI

A dissertation submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology (B.Tech) in the field of Food Technology

School of Industrial Technology

Universiti Sains Malaysia

June 2021

PUSAT PENGAJIAN TEKNOLOGI INDUSTRI UNIVERSITI SAINS MALAYSIA

BORANG PENYERAHAN DISERTASI MUTAKHIR SATU (1) NASKAH

Nama penyelia: Dr. Tan Thuan Chew

Bahagian: Senior Lecturer

Saya telah menyemak semua pembetulan/pindaan yang dilaksanakan oleh Encik/Puan/Cik Nurul Haziqah binti Khairuk Affendi

mengenai disertasinya sebagaimana yang dipersetujui oleh Panel Pemeriksa di *Viva Voce*-nya.

2. Saya ingin mengesahkan bahawa saya berpuashati dengan pembetulan/pindaan yang dilaksanakan oleh calon.

Sekian, terima kasih.

(Tandatangan dan cop)

Dr. Tan Thuan Chew
Senior Lecturer
School of Industrial Technology
Universiti Sains Malaysia

30/08/2021

Tarikh

DECLARATION BY AUTHOR

This dissertation is composed of my original work and contains no material previously published or written by another person except where due reference has been made in the text. The content of my dissertation is the result of work I have carried out since the commencement of my research project and does not include a substantial part of work that has been submitted to qualify for the award of any other degree or diploma in any university or other tertiary institution.

_____

NURUL HAZIQAH BINTI KHAIRUL AFFENDI

JUNE 2021

ACKNOWLEDGEMENTS

First of all, I would like to thank my final year project supervisor, Dr. Tan Thuan Chew for the invaluable support, advice, continuous support and patience during the running of this project. Without his encouragement, this journey would not be possible.

Besides, my completion of this project could not have been accomplished without the support of my school, School of Industrial Technology at Universiti Sains Malaysia for providing the facilities and research equipment needed in the lab to produce and complete my thesis. To lab assistants, Kak An, Encik Rahim and others who have willingly devoted time in giving guidance and assisting me and my friends in the lab, a big thank you to them.

Last but not least, I would like to thank all my friends and family for helping me survive all the stress throughout this journey and encourage me to not give up. Finally, I could not have completed this dissertation without the support from them.

NURUL HAZIQAH BINTI KHAIRUL AFFENDI
JUNE 2021

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

Abbreviation	Caption
rpm	Revolutions per minute

EKSTRAK PROTEIN DARI BELALANG JUTA (*LOCUSTA MIGRATORIA*) MELALUI KAEDAH ASID

ABSTRAK

Serangga yang boleh dimakan terbukti mempunyai kandungan protein yang tinggi dan berpeluang potensi untuk menghadapi ketidakamanan makanan dan nutrisi. Walau bagaimanapun, penerimaan keseluruhan entomophagy, atau amalan memakan serangga, tidak biasa di beberapa wilayah disebabkan penggunaan makanan moden, struktur sosial yang berubah dan perubahan demografi. Belalang juta (*L. migratoria*) boleh menjadi salah satu sumber alternatif protein dari kumpulan serangga yang boleh dimakan kerana ia sangat berkhasiat dan halal untuk dimakan oleh Muslim. Tujuan kajian ini adalah untuk menganalisis metodologi pengekstrakan yang optimum untuk larutan protein dari serbuk belalang juta (*L. migratoria*) dengan menggunakan kaedah asid. Kaedah pengekstrakan lipid menggunakan etanol akan diikuti dengan pengekstrakan protein dengan menggunakan asid askorbik sebagai medium berasid. Belalang juta bersumber dari Shondong, China ini mengandungi protein yang banyak. Ia telah dibahagi dengan dua pecahan iaitu pecahan belalang juta tidak larut dan pecahan supernatan semasa pelarutan protein. Hasil kajian ini memuaskan untuk mempertimbangkan kajian lanjutan dan melaksanakan serangga sebagai sumber makan untuk manusia dan haiwan.

THE PROTEIN EXTRACTION FROM LOCUST (*LOCUSTA MIGRATORIA*) VIA ACID METHOD

ABSTRACT

Edible insects have been shown to be high in protein content and a potential solution to encountered food and nutrition insecurity. However, the overall acceptance of entomophagy, or the practice of consuming insects, is not common in some regions due to increasing adoption of modern foods, changed social structures and changes in demography. Locusts (*L. migratoria*) could be one of an alternative protein source from edible insects because they are highly nutritious and "halal' to eat for for Muslim market. The aim of this study is to analyze the optimum extraction methodologies for solubilisation of protein from locusts (*L. migratoria)* powder using acid method. The method of lipid extraction using ethanol followed by protein extraction was carried out using ascorbic acid as an acidic medium. Locusts sourced from Shondong, China contained a high amount of protein. It was divided by two fractions; insoluble locust fraction and a supernatant fraction during the protein solubilization. The results are satisfactory to consider further studies and to implement insects as a source of nourishment for humans and animals.

CHAPTER 1: INTRODUCTION

1.1 Research Background

Recently, there has been a growing interest to search for a sustainable alternative protein source from insects in the developed and less developed countries. According to the Food and Agriculture Organization (FAO, 2009), the world's population is expected to reach 9.1 billion people in 2050. As the world's population grows, increased consumer demand for protein and a limited supply of usable agricultural land, sustainable meat production will be a serious challenge in the future. As a result, existing food production would have to substantially triple with nutrition and food security. Suggested solutions by researchers are reducing meat consumption, increasing the efficiency of the food chain from 'field to fork', or changing diets towards food commodities requiring less land (Van Huis A. et al., 2015). The development of insects as alternative protein sources has the potential to contribute to food and nutritional security. Currently, insect consumption has become an acceptable food culture in about one hundred and thirteen (113) countries in the world (Jongema, 2017). In addition, the statistics of the insect-based food market have begun to grow tremendously and several food industries have started to enter the sector, which is expected to be worth 1.2 billion U.S dollars by 2023 (Shahbandeh M., 2018). Due to the increasingly used of insects in processed foods globally, one of the primary criteria for Muslim around the world to eat insect-based food products is that the food product is halal. In Islamic Literature, the locust was declared halal when the Holy Prophet Muhammad (peace upon him) was reported to have said: "There are two dead (animals) that are permitted to us (to consume without slaughter); the fish and

the locusts" (Ibn Majah, Chapters on Hunting, Hadith No.3218) (Tajudeen A. L., 2020). Hence, alternative solutions to conventional livestock and feed sources need to be developed immediately.

In general, proteins are essential components for the human body providing essential and nonessential amino acids. Amino acids are the building blocks, which are necessary for the human growth, maintenance and development of the body. The majority of animal protein sources, such as meat, poultry, fish and dairy provide all of the amino acids for the human body. However, 70% of the world's agricultural land is already directly used for meat production (WUR, n.d.). For this reason, entomophagy offers a huge opportunity to overcome the protein gap in human diets. The nutritional value of edible insects are rich in amounts of protein, fats, iron, calcium and low in carbohydrates depending on their metamorphosis variability of species. Of all the major edible insects, locusts are excellent sources of protein and other essential nutrients (Joost Van Itterbeeck, 2020).

The locust *(Locusta Migratoria*) is a big herbivorous edible insect belonging to Orthoptera. In Africa, Middle East and Asia, locusts have been a part of a local diet for the most well-known edible grasshopper for centuries. This insect is still eaten in rural and urban areas. It contains 50.42% crude protein, 19.62% crude fat, 4.78% carbohydrates, 15.65% fiber, 6.24% ash, 3.8% moisture content (Mohamed E. H., 2015). The locusts are considered rich in nutritional value and a good food source of most nutrients in terms of protein, fat and fiber according to the findings. Additionally, locust have received attention for their promising sensory properties, nutritionally rich

composition and sustainable production prospects as food ingredients (Mariod, 2020; van Huis et al., 2013).

The issue of regulations, most of the countries have not set regulations for incorporating insects in food along with the disgust and horror in general. Thus. it is hardly to be overcome among the major limiting factors hindering insect farming to supply in food industries. Nevertheless, to reduce insect food neophobia, previous studies proposed to insert into various food preparations (Megido R. C. et al., 2016). Hence, the development of food products with the insect integration, such as protein extraction is a major challenge for food technologists. Different proteins require different conditions and methods. Many alternatives to protein extractions have been implemented such as aqueous, acid and alkaline extraction.

1.2 Problem statement

Protein sources are the second largest component of practical poultry diets (Iji P. et al., 2017). Hence, there is increased demand for protein-supply that is coming from several sources such as poultry, fish and meat industry. This animal-derived protein requires a lot of land and water compared to insects. This successively increases the conversion of forests, wetlands and natural grasslands into agricultural lands, which in itself has negative consequences for greenhouse gas emissions, biodiversity and other important ecosystem services (Foley, J. A et al. 2011; Godfray, H. C. J. et al. 2010; van Zanten H. H. et al. 2016). Moreover, protein undernutrition is also one of the concerns in the future. According to Wu G., (2016), protein undernutrition would result in stunting, anemia, physical weakness, edema, vascular dysfunction and impaired immunity.

According to the Food and Agriculture Organization of the United Nations (FAO, 2014), about 805 million people worldwide are chronically undernourished, with particularly low levels of food security. Based on short-term nitrogen balance studies, the Recommended Dietary Allowance of protein for a healthy adult with minimal physical activity is 0.8 g protein per kg body weight (BW) per day (Wu G., 2016). This shows that there is the potential to encourage entomophagy for food and nutrition security by adding value in food processing (Ayieko M. et al., 2010; Kinyuru J. N. et al., 2009).

However, the characteristics and functional properties of protein extract from insects are rarely discussed and remain unclear. In terms of potential food uses, the possibility of protein extracts from insect creating gels using the soluble fractions is seen as promising. More studies on the protein extraction from insects is needed to improve and vary the extraction and purification process and its solubility. Another study by Yi et al. (2013) who publishes about the protein extraction via aqueous method suggested to improve the functional properties of protein solutions.

Protein extraction methods can vary widely depending on the properties of insects, yet there is minimal research comparing protein isolation techniques. Most insects have aphid-like characteristics that make protein extraction scientifically challenging. Proteins extraction is usually carried out via aqueous or alkali isoelectric precipitation, in which different pH, temperature, and physical separation (centrifugation) methods are used to separate different fractions (Bußler et al., 2016; Clarkson et al., 2018).