

UNIVERSITI TEKNOLOGI MARA

THE PHYSICOCHEMICAL
PROPERTIES OF CHOLESTEROL-
REDUCED EGG YOLK POWDER
PRODUCED BY REMOVAL OF β -
CYCLODEXTRIN INCLUSION
COMPLEX AND ITS APPLICATION
IN MAYONNAISE

FAUZIAH BINTI CHE IN

Thesis submitted in fulfilment
of the requirement for the degree of
Master of Science

Faculty of Applied Sciences

March 2018

ABSTRACT

Association of eggs to high cholesterol level in body is greatly known. Liquid egg yolk is also difficult to transport due to their bulkiness, fragility and highly perishable. Egg yolk powder with reduced cholesterol content would be beneficial and nutritious to consume. Therefore, the aim of this study is to reduce egg yolk cholesterol by using P-cyclodextrin at different concentrations and the quality of cholesterol reduced egg yolk powder was analysed for mayonnaise production, p-cyclodextrin concentration used were at a range of 0-15 mM. At 15 mM P-cyclodextrin, egg yolk powder was successfully produced with 98.12% of cholesterol reduction. However, no significant reduction ($p>0.05$) was noticed in the lipid content range from 55 ± 13.23 to 48 ± 0.10 g/100gm. The process of cholesterol removal caused significant reduction ($p<0.05$) in protein range from 38.86 ± 0.26 to 35.43 ± 0.16 g/100gm and in saturated fatty acids range from 154.7 ± 6.09 to 61.62 ± 0.54 mg/g, monounsaturated fatty acids range from 240.23 ± 6.75 to 90.09 ± 0.53 mg/g and polyunsaturated fatty acids range from 28.97 ± 0.28 to 20.74 ± 0.002 mg/g. Cholesterol-reduced egg yolk powder and its inclusion complex produced at 15 mM were characterised using Differential Scanning Calorimetry (DSC), Fourier Transform Infrared Spectroscopy (FTIR), Scanning Electron Microscopy (SEM) and X-Ray Diffraction (XRD) followed with its application in mayonnaise. Results obtained indicate that cholesterol: P-cyclodextrin inclusion complex behave differently when compared with egg yolk cholesterol: P-cyclodextrin inclusion complex which showed that compounds other than cholesterol might be encapsulated in egg yolk cholesterol inclusion complex. Mayonnaise made using cholesterol-reduced egg yolk were further analysed. Emulsion capacity and emulsion stability were analysed, and the results showed no significant difference ($p>0.05$) between egg yolk powder-without cholesterol removal (emulsion capacity: $58.43\pm 4.73\%$, emulsion stability: $58.52\pm 1.78\%$) and cholesterol reduced egg yolk powder (emulsion capacity: $59.82\pm 3.41\%$, emulsion stability: $56.06\pm 2.07\%$). However, viscosity of mayonnaise prepared from cholesterol-reduced egg yolk powder (8000 ± 16.0 cP) was differ significantly ($p<0.05$) from egg yolk powder-without cholesterol removal (4768 ± 16.0 cP). Egg yolk powder-without cholesterol removal was differed significantly ($p<0.05$) from cholesterol-reduced egg yolk powder in term of lightness (L^*), redness (a^*), yellowness (b^*), chroma (C^*) and hue angle (h°) values. The results obtained for sensory characteristics showed no significant difference ($p>0.05$) in term of overall acceptability between mayonnaise made using egg yolk powder-without cholesterol removal and cholesterol-reduced egg yolk powder with 6.30 ± 1.09 and 6.23 ± 1.14 , respectively. Therefore, p-CD can be used to produce cholesterol-reduced egg yolk powder and healthier food products.

ACKNOWLEDGEMENT

Sincerely thank to Allah S.W.T (Alhamdulillah) for giving me the opportunity to embark on my MSc and for successfully completing this challenging and long journey of study. I also want to sincerely thank to my mother and father for their endless support and encouragement, both intellectual and financial they had given to me to reach this higher level of education.

My gratitude and thanks to my supervisors, Assoc. Prof. Dr Zaibunnisa Abdul Haiyee, Prof. Dr. Osman Hassan and Prof. Dr. Wan Aida Wan Mustapha. Thank you for the support, criticism, patience, persistence and ideas in assisting me with this research project.

I also would like to express my gratitude to the fellow laboratory staffs; Puan Nora, Cik Hariyah and Puan Shaheda for their assistance and expert technical advice with GC-MS and GC-FID analysis; Encik Ayub for helpful assistance with SEM equipment; Encik Kamaruddin for FTIR analysis, Puan Siti Marhani, Puan Nurashikin and Cik Shuhada for their helpful assistance and supports. Special thanks to Mae Fah Luang University, Chiang Mai Thailand for Fourier Transform Infrared Spectroscopy (FTIR) and X-Ray Diffraction (XRD) analysis equipment.

Finally, to all my family and friends, for their support, advice and helps, I extended to them sincere thanks.

This thesis is dedicated to my father, Che In Ramli and my mother,
for their endless support and encouragement along the way of finishing this study. This piece of victory is dedicated to both of you. With that, again thank you so much. May Allah bless. Alhamdulillah.

TABLE OF CONTENTS

	Page
CONFIRMATION BY PANEL OF EXAMINERS	ii
AUTHOR'S DECLARATION	iii
ABSTRACT	iv
ACKNOWLEDGEMENT	v
TABLE OF CONTENTS	vi
LIST OF TABLES	x
LIST OF FIGURES	xi
LIST OF SYMBOLS	xiii
LIST OF ABBREVIATIONS	xiv
LIST OF NOMENCLATURES	xv
CHAPTER ONE: INTRODUCTION	1
1.1 Background of Research	1
1.2 Problem Statement	5
1.3 Objectives of Study	6
1.4 Significance of Study	6
1.5 Scope and Limitation of Study	6
CHAPTER TWO: LITERATURE REVIEW	8
2.1 Chicken Egg	8
2.1.1 Global Hen's Egg Production	8
2.1.2 Malaysian's Egg Consumption and Production	9
2.1.3 Structure and Nutritional Composition of Egg	10
2.1.3.1 Protein	11
2.1.3.2 Lipid	13
2.1.3.3 Fatty Acids	14
2.1.3.4 Cholesterol	16
2.1.4 Transport of Cholesterol in the Bloodstream	18
2.1.5 Egg Cholesterol Content	19

2.1.6	Pigments of Egg Yolk	21
2.1.7	Egg Yolk Cholesterol and Association to Diseases	23
2.1.8	Egg Yolk Powder and Potential of Cholesterol-reduced Egg Yolk	25
2.2	Cyclodextrin	27
2.2.1	Introduction	27
2.2.2	β -cyclodextrin	29
	2.2.2.1 General Properties of β -cyclodextrin	29
	2.2.2.2 β -cyclodextrin as Cholesterol Binder	29
2.2.3	Mechanism of Inclusion Complex Formation	31
2.3	Emulsion	34
2.3.1	Classification of Emulsion	34
2.3.2	Emulsion Properties	34
2.3.3	Mayonnaise	35
	2.3.3.1 Low-fat Mayonnaise	35
2.3.4	Egg Yolk as Emulsifier	36
2.4	Reduction of Cholesterol From Egg Yolk	38
2.5	Processing of Egg	40
2.6	Effect of Egg Yolk on the Quality of Food Products	42
2.7	Characterisation of Formation of Inclusion Complex	43
	2.7.1 Fourier Transform Infrared Spectroscopy	43
	2.7.2 Differential Scanning Calorimetry	45
	2.7.3 Scanning Electron Microscopy	46
	2.7.4 X-Ray Diffractions	46
CHAPTER THREE: RESEARCH METHODOLOGY		48
3.1	Materials	48
3.2	Methods	48
	3.2.1 Preparation Cholesterol-reduced Egg Yolk Powder	48
	3.2.2 Preparation and Determination of Cholesterol Standard	49
	3.2.3 Cholesterol Egg Yolk Determination	50
3.3	Determination of Fatty Acids Methyl Esters of Cholesterol-reduced Egg Yolk Powder	50
	3.3.1 Sample Preparation	50
	3.3.2 Gas Chromatography Mass Spectrometry Analysis	51