



**INTEGRATION OF HACCP PRINCIPLES IN DEVELOPING CENTRALISED
KITCHEN CONCEPT TOWARDS SAFER FOODS IN JUNIOR SCIENCE
COLLEGES IN PERAK AND KEDAH, MALAYSIA**

By

DORA LIYANA BINTI ABD LATAF

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfilment of the Requirements for the Degree of Doctor of Philosophy**

December 2022

FSTM 2022 29

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DEDICATION

With full of gratitude, this thesis is dedicated to my beloved parents, Puan Linda Hanim and Tuan Haji Abd Lataf, and in the loving memory of my dearest grandmother, Hajjah Zon Aziah and uncle, Rozlan Hisham. May Allah s.w.t. grant them the highest Jannah for their endless love, support and encouragement.



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

INTEGRATION OF HACCP PRINCIPLES IN DEVELOPING CENTRALISED KITCHEN CONCEPT TOWARDS SAFER FOODS IN JUNIOR SCIENCE COLLEGES IN PERAK AND KEDAH, MALAYSIA

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December 2022

Chairman : Associate Professor Nor Ainy binti Mahyudin, PhD
Faculty : Food Science and Technology

Students aged 7 to 17 years were exposed to the risk of food poisoning, which are associated with unhygienic preparation of foods sold and served in schools. The problem with the current conventional foodservice system is it poses high microbiological risk of food safety issues, has no food safety assurance program, very short food shelf-life, and time-consuming. The cook-chill method is the most efficient system for a central kitchen where foods are cooked, packaged, and rapidly chilled before transported to satellite kitchens. MARA Junior Science Colleges (MJSCs) in Perak and Kedah were selected because these states have the most number of MJSCs in Malaysia and the proposed centralised kitchen is located in Perak. The objectives of this study are (i) to evaluate the food safety and hygiene knowledge, attitude, and practices (KAP) of food handlers and managers in MJSCs; (ii) to develop a hazard analysis critical control point (HACCP) system for cook-chill centralised kitchen; (iii) to validate the cooking process using isothermal inactivation method; (iv) to validate the rapid chilling process by evaluating microbial growth before and after chilling process; and (v) to validate the cold storage by real-time shelf-life study on cook-chill beef kurma. Food safety KAP surveys were administered to MJSCs kitchen food handlers using a self-administered questionnaire, on-site observation, and personal interview. Development of a HACCP system and improvement on current Standard Operating Procedures for the cook-chill central kitchen in preparation of the cook-chill beef cooked in spices dish were based on MS1480:2019. Validation for cooking of beef was determined using the isothermal inactivation method whereby whole muscle beef inoculated with *Salmonella* Enteritidis and *Salmonella* Typhimurium was cooked in four different temperatures at different time intervals. Bacteria's survival rate was plotted. Multi-point mapping was used to identify hot spot in blast chiller in the validation of rapid chilling process. The cold storage shelf-life validation of cook-chilled beef kurma was carried out for 4-days using a real-time shelf life study and microbiological, physicochemical, and sensory quality were determined. This study shows that all food handlers (n=134) have excellent knowledge, a positive attitude, and good self-reported practices regarding food safety and hygiene

with a mean percentage(SD) score of 65.2%(12.7), 92.3%(16.2), and 73.0%(15.0) respectively. However, on-site observation conducted shows some practices are different from the ones reported by the food handlers. Three processes were determined as CCPs, which are the cooking of beef, rapid chilling, and cold storage. The D-values for the cooking of whole muscle beef are $D_{58^{\circ}\text{C}}=5.41\text{min}$, $D_{60^{\circ}\text{C}}=2.03\text{min}$, $D_{62^{\circ}\text{C}}=0.46\text{min}$ and $D_{64^{\circ}\text{C}}=0.18\text{min}$. The validation of rapid chilling found that there is no significant difference in microbial growth before and after chilling process of beef kurma at 0-3°C for <120 minutes. In the cold storage shelf-life validation, the microbiological quality food tested was within the acceptable limit for all 4-days. By using the duo-trio test, panellists could differentiate between the freshly cooked beef kurma and cook-chill beef kurma ($p<0.05$). Findings from this study present an insight into food safety towards the implementation of the HACCP principles and food preparation in developing a cook-chill centralised kitchen concept in schools' foodservice operations.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**INTEGRASI PRINSIP HACCP DALAM USAHA MEMBANGUNKAN
KONSEP DAPUR BERPUSAT KE ARAH PENYEDIAAN MAKANAN
SELAMAT DI MAKTAB RENDAH SAINS MARA DI PERAK DAN KEDAH,
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Pelajar berumur 7 hingga 17 tahun terdedah dengan risiko keracunan makanan, yang dikaitkan dengan penyediaan dan penghidangan makanan yang tidak bersih di sekolah. Permasalahan yang berkaitan dengan sistem perkhidmatan makanan konvensional semasa adalah ia mendedahkan makanan kepada risiko keselamatan yang tinggi iaitu terhadap mikroorganisma, ketiadaan program jaminan keselamatan makanan, jangka hayat makanan yang singkat dan memerlukan masa penyediaan yang lama. Kaedah penyediaan makanan masak-sejuk adalah sistem yang efisien pada sesebuah dapur berpusat, di mana makanan dimasak, dibungkus dan melalui penyejukan pantas sebelum dihantar ke dapur satelit. Maktab Rendah Sains MARA (MRSM) di Perak dan Kedah dipilih untuk kajian ini adalah kerana kedua-dua negeri mempunyai bilangan MRSM yang terbanyak di Malaysia dan cadangan dapur berpusat terletak di Perak. Objektif kajian ini adalah (i) untuk menilai pengetahuan, sikap dan amalan (KAP) pengendali makanan dan penyelia MRSM terhadap keselamatan makanan, (ii) untuk membangunkan sistem titik kawalan kritikal analisis bahaya (HACCP) untuk dapur pusat masak-sejuk, (iii) untuk menesahkan proses memasak menggunakan kaedah penyahaktifan isothermal, (iv) untuk mengesahkan proses penyejukan pantas dengan menilai pertumbuhan bakteria sebelum dan selepas penyejukan, dan (v) untuk mengesahkan jangka hayat di penyimpanan sejuk menggunakan kaedah penentuan jangka hayat sebenar bagi makanan kurma daging lembu sejuk-dingin. Tinjauan berkaitan pengetahuan, sikap dan amalan (KAP) keselamatan makanan dijalankan ke atas pengendali makanan dapur dengan menggunakan borang soal selidik, pemerhatian di lapangan dan sesi temuramah secara bersemuka. Pembangunan sistem HACCP dan penambahbaikan Prosedur Operasi Piawai sedia ada untuk dapur pusat masak-sejuk telah dijalankan menggunakan piawaian MS1480:2019. Pengesahan bagi proses memasak daging lembu ditentukan menggunakan kaedah penyahaktifan termal di mana daging lembu yang dipotong secara kiub diinokulasi dengan *Salmonella* Enteritidis dan *Salmonella* Typhimurium, dimasak pada empat suhu berbeza dengan selang masa yang

berbeza. Graf kelangsungan hidup bakteria disediakan. Untuk pengesahan proses penyejukan pantas, kaedah pemetaan di pelbagai titik digunakan untuk mengenal pasti titik panas dalam peti penyejuk. Pengesahan jangka hayat kurma daging lembu yang dimasak sejuk telah dijalankan selama empat hari di mana sifat mikrobiologi, fizikalkimia dan deria ditentukan. Kajian ini menunjukkan bahawa semua pengendali makanan ($n=134$) mempunyai pengetahuan yang sangat baik, sikap positif dan amalan laporan sendiri yang baik mengenai keselamatan dan kebersihan makanan dengan peratusan purata(SP) skor 65.2%(12.7), 92.3%(16.2) dan 73.0%(15.0). Walau bagaimanapun, pemerhatian di lapangan mendapati terdapat beberapa amalan pengendali makanan yang berbeza dengan amalan yang telah dilaporkan. Tiga proses telah ditentukan sebagai titik kawalan kritikal, iaitu proses memasak daging, penyejukan pantas, dan penyimpanan sejuk. Nilai-D untuk daging lembu yang dipotong secara kiub ialah $D_{58^{\circ}\text{C}}=5.41\text{min}$, $D_{60^{\circ}\text{C}}=2.03\text{min}$, $D_{62^{\circ}\text{C}}=0.46\text{min}$ dan $D_{64^{\circ}\text{C}}=0.18\text{min}$. Pengesahan penyejukan pantas mendapati perbezaan pertumbuhan bakteria sebelum dan selepas penyejukan adalah tidak signifikan selepas kurma daging lembu disejukkan pada $0-3^{\circ}\text{C}$ selama <120 minit. Dalam pengesahan jangka hayat, kualiti mikrobiologi makanan yang diuji adalah dalam had yang boleh diterima untuk kesemua empat hari dan penilaian deria menggunakan ujian duo-trio menunjukkan ahli panel boleh membezakan antara sampel kurma daging yang dimasak segar dan kurma daging sejuk dingin ($p<0.05$). Dapatan kajian ini memberikan gambaran tentang keselamatan makanan ke arah pelaksanaan prinsip HACCP dan penyediaan makanan dalam membangunkan konsep dapur berpusat dalam operasi perkhidmatan makanan sekolah.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

HACCP	Hazard Analysis Critical Control Point
GMP	Good Manufacturing Practice
MeSTI	Makanan Selamat Tanggungjawab Industri
BeSS	Bersih, Selamat dan Sihat
RTE	Ready-to-eat
CFU/g	Colony forming unit per gram
KAP	Knowledge, attitude and practice

CHAPTER 1

INTRODUCTION

1.1 Background

Food safety has received much emphasis by agencies worldwide because it may lead to foodborne illness. Foodborne illnesses cover a wide range of diseases and it is a growing public health concern as it has caused morbidity and mortality worldwide. Foodborne illness occurs through the ingestion of contaminated foods. The contaminants can be from microorganisms or even chemicals (WHO, 2007).

Contamination of food may occur at any point along the food production chain to end consumer. Food safety is defined as “the conditions and measures that are necessary along the food production chain to ensure that it is safe, sound and fit for human consumption” (FAO/WHO, 2001). Food is considered safe when it is free from chemical, biological or physical hazard that may result in illnesses or even death to the consumers. Food safety is a concern as it posed risks to the population, especially to the vulnerable groups such as infants and young children, elderly individuals and those with immunodeficiency disorder (Soon, Singh, & Baines, 2011).

There are several factors which contributed to the emergence of foodborne illness (Altekruse, Cohen, & Swerdlow, 1997; Ismail et al., 2016; WHO, 2015). These includes (i) globalisation of the food supply which has led to rapid and widespread distribution of foods, (ii) advances in food production and processing technologies, (iii) changes in agricultural and animal husbandry practices, (iv) evolution of food borne pathogens, (v) microbial adaptation where microbial can be accidentally introduced into new geographical area and (vi) demographic and lifestyle changes where meals are eaten out of home or non-prepared at home.

The much attention given to food safety is also due to the upward trend of incidence rate of foodborne illnesses in the past 20 years for both locally (Abdul-Mutalib et al., 2012; Meftahuddin, 2002; Ministry of Health Malaysia, 2019; Soon et al., 2011) and international (CDC, 2014). Diseases like cholera, typhoid fever, hepatitis A, dysentery and food poisoning are examples of foodborne illness. These diseases are associated with infection of pathogens in the gastrointestinal system.

Food poisoning incidence rate trend in Malaysia also varies from 2008 to 2018. The upward trend could be seen in the year 2009 to 2011 where the incidence rate increases from 36.2 per 100 000 population to 56.3 per 100 000 population. The trend increases again in year 2012 to year 2014 where the incidence rate increases from 44.9 per 100 000 population in 2012 to 58.7 per 100 000 population in 2014. Although the upward trend in overall food poisoning incidence, the food poisoning episode trend in schools in Malaysia show a decreasing trend for the past five years (2014 to 2018) (Ministry of Health Malaysia, 2019). However, outbreaks involving school children still happened.

This situation is worrying as school children belongs to the vulnerable groups which has low immunity level compared to adults. This will also affect their studies where time to recover from food poisoning may take days.

Salmonella is a major a global issue whereby it could cause foodborne illness. In 2011, there were 95,548 confirmed cases of salmonellosis in the European Union. *Salmonella* spp. are responsible for the largest number of deaths from foodborne pathogens in the United States, despite the relatively low death rate of 0.5%. Similarly, in Australia in 2014, approximately 16,000 cases of salmonellosis were reported (Gurman, Ross, Holds, Jarrett, & Kiermeier, 2016). School outbreaks related to *Salmonella* illustrate the health and financial impact of school-related foodborne illness (Youn & Sneed, 2003). Incidence of salmonellosis is not known in Malaysia as there are no published data related to this disease. A study conducted in Malaysia on the prevalence of *Salmonella* spp. in raw foods and ready-to-eat cooked foods shows that raw foods such as beef and chicken breast were contaminated with *Salmonella* spp. and food obtained from the street vendors such as satay are positive with *Salmonella* spp. (Ain Auzureen et al., 2017; Arumugaswamy, Gulam Rusul, Siti Nadzriah, & Cheah, 1995; Shafini, Son, Mahyudin, Rukayadi, & Tuan Zainazor, 2017).

A conventional kitchen is where ingredients are assembled and on-site food preparation and cooking are carried out (Stinson, Carr, & Nettles, 2010). Foods prepared may be hold hot or hold chilled. The challenges faced by conventional kitchen operators are that foods are perishable, requires proper handling before, during and after preparation and production changes daily as menu is changed daily. This creates challenges in the conventional kitchen. Schools recorded the highest food poisoning cases over the years may be due to the kitchen system used that is the conventional kitchen. This may be because the time required to prepare mass meals a day in conventional kitchen is short (Marzano & Balzaretto, 2011). This will cause food handlers to prepare food very early in the morning or even the day before which would increase the chance of bacterial growth.

Although conventional kitchens are widely used, there is an alternative of a centralised kitchen producing foods using the cook-chill, cook-freeze system or even hot hold. A centralised kitchen is the centre of commissary food service system. The quality and standardisation of food production together with consistent quality nutritional profile improves with centralisation when compared to conventional kitchen (National Food Service Management Institute, 2004) . At present, all schools in Malaysia are using the conventional kitchen with hot hold meal production.

The MS ISO 22000:2012 (DSM 2012) specifies requirements for a food safety management system where an organization in the food chain needs to demonstrate its ability to control food safety hazards in order to ensure that food is safe at the time of human consumption. The purpose of food safety management system is to ensure that a food business regulated itself everyday. The key elements specified in the food safety management system to ensure food safety along the food chain are interactive communication, system management, pre-requisite programs and HACCP principles. This covers storage, maintenance of the equipment and hazards free environment.

However, the implementation of MS ISO 22000:2012 or other food safety assurance programs in Malaysia is still on voluntary basis for both commercial and non-commercial food service industry. For school kitchen that prepares mass food everyday with different types of menu, control of food safety hazard is very important to ensure food is safe before consumption by students and teachers. Therefore, the implementation of HACCP in the school kitchen is much encouraged, as it guarantees the safety of foods prepared and served to customers.

Food safety has received much emphasis by government because of the potential health and economic impact of food borne illnesses (Hwang & Sneed, 2007; Youn & Sneed, 2003). At present, the hygiene and safety of food sold and prepared in school canteens and hostel kitchens in Malaysia are being monitored by the Food Safety and Quality Program, Ministry of Health Malaysia where risk based assessment is carried out and implementation of the Food Hygiene Regulations 2009 (ILBS, 2021).

Although food safety and hygiene assessment are being carried out by personnel from the Ministry of Health, the school is also responsible in doing their own self-assessment in school hostel kitchen. The program that has been introduced since 2008 to schools is the Self-Assessment Check Program (KENDIRI) where both school management and school kitchen operators are required to assess the school kitchen and food handlers' hygiene and merits will be given if it complies with the requirement in the checklist given. This program is later re-branded to Program Keselamatan Makanan (PROKEM).

The National Food Safety Plan (2010-2020), new initiatives that was introduced to school catering programs are to develop the Infrastructure and Facilities Guidelines for School Canteen and Boarding Schools' Kitchens, to develop canteen plan and structure and to prepare standard facilities and equipments in canteens and kitchens. Hence, the development of a centralised kitchen model is in accordance to this plan.

1.2 Problem Statement

Between year 2013 to 2016, 45 (4.5%) incidences of food poisoning in education institutions in Malaysia have occurred in Mara Junior Science College (MJSC), where about 24.4% cases involved MJSCs in Perak. While the incidence of school related foodborne disease outbreaks is low, efforts are still needed for risk reduction. Since school children has low immunity level compared to adults, they are easy to affect from food poisoning. This will eventually affect their studies also where time to recover from food poisoning may take days. Food handlers' knowledge, attitude and practices contributes to safe food handling. However, most of these studies were conducted on food handlers in school canteen and in addition, the knowledge, attitude and practices of canteen or kitchen supervisors on food safety were not evaluated. Knowledge has been positively correlated with self-reported practices, but, actual food handling practices were less observed. Hence, there is a need to evaluate both hostel kitchen's food handlers' and supervisors food safety knowledge, attitude, self-reported practices and on-site practices observation.

A centralised kitchen centralises food production where food is transported to satellite kitchens where it is served to customers. The centralised kitchen concept has been introduced to commercial food services in Malaysia where foods are held heated, stored chilled or stored frozen before reaching the receiving kitchens for heating and serving. Examples of commercial food services using the centralised kitchen concept are the airline industry, railway industry and extensively in restaurant corporations. The concept of centralised kitchen involving non-commercial food service however is still in its infancy stage. It has been observed that some of the hospitals in Malaysia are opting to serve their clients with foods prepared from centralised kitchens.

Most studies on centralised kitchen concept focussed on the operational and financial aspects (Fujii, Kaihara, Uemura, & Shimmura, 2013) and customers' satisfaction on the foods served (Ali & Akbar, 2015; Hwang & Sneed, 2007). However, studies concerning centralised kitchen concept towards safer foods especially in non-commercial food service operations is still limited (Barrie, 1996; Brown, 2005; Kim & Shanklin, 1999; Youn & Sneed, 2003). As of this study done, the centralised kitchen concept has not been introduced to school kitchens in Malaysia since all schools in Malaysia are at present using the conventional or on-site cooking system to prepare and serve food in schools.

Study shows centralised cook-chill system shows a more serving temperature inconsistency compared to the conventional system (Kim & Shanklin, 1999). However, the same study together with Youn and Sneed (2003) recommended standard operating procedures to be implemented to ensure food production consistency. Time and temperature abuse together with cross-contamination were found to cause food poisoning outbreaks and these were related to food handlers' practices in handling foods (Abadio, Taylor, Swainson, & Daramola, 2016; Baş, Ersun, & Kivanç, 2006b). Implementation of standard operating procedures in accordance with the GMP and HACCP principles can promote safer foods in centralised kitchen. Cuihua (2014) have proposed to establish a central kitchen under HACCP control in food and beverage industry mainly the catering industry, the present study will focus on the development of a central kitchen model using HACCP approach in school hostel kitchens which operates 12-18 hours daily. Hazard analysis for a protein based cuisine will be selected for this study as protein based foods are served daily to the students.

Types of meal produced have also been discussed to improve food safety, food quality and other aspects such as financial, nutritional value and customer satisfaction. Advantage of centralised production that incorporated cook-chill or cook-freeze systems are reduction of labor costs and control food quality (Brown, 2005; Green & Selman, 2005; Kim & Shanklin, 1999). Although cook-chill meal production does give advantages, however, its implementation in schools in Malaysia are stalled due to lack of funds and knowledge on food safety (Yusof et al., 2018).

The hazard analysis for Asian food using both hot-serve and cook-chill method such as Thai Pla Curry, mixed fried rice, beef keema and beef curry has been studied (Kandeepan, Anjaneyulu, Kondaiah, & Mendiratta, 2011; Kandeepan, Anjaneyulu, Kondaiah, Mendiratta, & Rajkumar, 2013; Lohalaksandech, Wittaya, & Sujarit, 2012; Noor Zafira

& Sharifah Hafiza, 2020). However, there is a need to explore the hazard analysis of cook-chill beef kurma, a dish regularly consumed by Asian population mainly in Malaysia and India and this dish is also regularly served in school kitchen.

Past studies has shown cooking time and temperature plays an important role in reducing or eliminating biological hazards in beef (Juneja & Eblen, 2000; Murphy, Osaili, Duncan, & Marcy, 2004). Most studies were conducted on ground beef, but it has been studied that the thermal death time of bacteria is also affected by the physical structure of the studied matrix (beef) (Velasquez et al., 2010). The beef served to students are in cube or in slices form. Therefore, there is a need to study the effect of time and temperature in bacteria death time in beef cubes. The critical limit of a critical control point (CCP) will be established in designing the HACCP plans to effectively eliminate hazards in cooked beef.

Cook-chilled food undergoes rapid chilling to cool food from high temperature to very low temperature (0-3°C) within 90 to 120 minutes. There are limited studies related to bulk RTE food chilling (Noor Zafira & Sharifah Hafiza, 2020; Poumeyrol et al., 2014; Yu et al., 2010). In Poumeyrol et al., (2014), the potential growth of *Clostridium perfringens* in cooked dish was evaluated using the probabilistic method, while Yu et al., (2010) studied on the quality of cooked rice after chilling. Therefore, for the present study, the effect of food storage cooling rate and deterministic of bacterial growth in different food matrix is required to validate the critical limits.

RTE food's shelf life especially hot-serve food is short when it did not undergo further process such as chilling or freezing and this contributes to food wastage. The shelf life during chilled storage of cook-chilled RTE meat dish are yet to be demonstrated as the effect of food matrix size and refrigerated storage on the overall quality of microbial, physicochemical and sensory quality. A shelf-life and food quality study of a beef based local cuisine using the cook-chill method will need to be carried out to achieve optimum quality and the customer's satisfaction.

Focus of the present study is the validation of the hazard analysis of cook-chilled beef dish. Validation study is required to prove that the critical limit chosen is reliable, accurate and precise to control the hazards in the process or raw material. Three validation studies namely the cooking process, the rapid chilling process and cold storage were studied to prove the effectiveness of the critical limit. The validity of the HACCP plan for cook-chilled RTE meat dish are required so that the food service industry, mainly the proposed central kitchen could use the HACCP plan without doubts. Therefore, the cooking, rapid chilling and storage shelf life validations for cook-chilled RTE meat dish should also account for the actual food product size and portion to ensure microbial safety. Laboratory simulation of a central kitchen was used in the present study to attempt to control and monitor time and temperature of processing cook-chilled RTE meat dish according to the recommendation contained in the HACCP and GMP model for quality control of the food production in cook-chill system.

This study offers new insights of this important new area in education institution which is on the production of cook-chilled centralised kitchen. To date, implementation of the HACCP system in school hostel kitchen in Malaysia has not been carried out. Hence, there is a need to implement a documented food safety management procedures based on the HACCP approach in schools in prevention of food borne diseases. Apart from that, another benefit of this study is providing the food industry with new knowledge on bacterial survival in foods cooked using whole muscle beef in contra to ground beef which often used in past studies. Besides, the microbial, physicochemical qualities and sensory evaluation findings from storage of cook-chill beef dish in bulk for a period of time would assist food processors in managing food in the kitchens, with the aim of providing safe foods to their customers.

1.3 Objectives

This study aimed to analyse and evaluate the establishment of HACCP principles in implementing a centralised cook-chill food service system in school hostel kitchen toward increasing the food safety quality of food served. The specific objectives are:

- i. To evaluate the food safety and hygiene knowledge, attitude and practices of food handlers and managers in school food service operations
- ii. To develop hazard analysis and critical control point system for cook-chill central kitchen in preparation of cook-chill beef cooked in spices dish
- iii. To validate the cooking process (CCP 1) using isothermal inactivation method
- iv. To validate the rapid chilling process (CCP 2) by evaluating the microbial growth before and after chilling process
- v. To validate the cold storage (CCP 3) by real-time shelf-life study on cook-chilled beef kurma

1.4 Thesis outline

The thesis is organised into 8 Chapters comprised of 5 working Chapters. Chapter 1 presents the overall introduction to the thesis, Chapter 2 presents the overview of food poisoning episodes both locally and globally, types of kitchen system, review on the role of food handlers in ensuring food safety and review of food safety assurance programs. In addition to previous studies on cook-chill foods, the review also discussed on the microbial quality of cook-chill food together with validation parameter on cook-chill product. The 5 research objectives were written in working Chapters which are from Chapter 3 to Chapter 7. Lastly, Chapter 8 summarises, concludes and provides recommendations for future studies based on the findings from this present study.

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