



UNIVERSITI PUTRA MALAYSIA

***EFFECTS OF HOLDING AND REHEATING TIME USING MICROWAVE
ON MICROBIAL LOAD OF READY-TO-EAT FOODS IN SELECTED
RESTAURANTS IN SELANGOR, MALAYSIA***

MOHAMED ADEN HERSI

FSTM 2019 5



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By

MOHAMED ADEN HERSI

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

July 2018

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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July 2018

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

Due to changes in the lifestyle of societies, the demand of ready to eat (RTE) food is on the increase worldwide. In Malaysia urbanization has affected how and where people get their foods. Eating out has become part of the Malaysian culture and hence the need to examine the quality of RTE foods served at local restaurants. The aim of this study was to assess the effect of holding and the microwave reheating times on the microbial content of RTE foods prepared and served at local restaurants. A total of 120 samples were analyzed to evaluate the effect of holding time and on the microbial content of the food samples. Four samples of each food type from every restaurant were microbiologically tested for Coliforms and Escherichia coli bacteria. Another set of samples, 120 samples from the same restaurants were collected to estimate the effect of varying microwave reheating time on the microbial content of the food. However, this time, samples were analyzed after being subjected to different levels of microwave time; namely, 0 seconds, 30 seconds, 45 seconds and 60 seconds. Out of the collected samples, which were, Plain Rice (PR), Roti Canai (RC), Fried Chicken (FC), Chicken Fried Rice (CFR), Fried Noodles (FN), and Nasi Lemak (NL); FN had the highest microbial content of both Coliform contents ranging from 3.6 to over 1100 MPN/g. Nonetheless, although there was an increase in the number of microorganisms in the samples tested, holding time had no significant effect on the microbial content of any of the samples tested, except for FN and NL where the holding time significantly affected the microbial load. The effect of the microwave time on microbial load was a statistically significant one. This was observed in the TPC content of all the samples except for RC, PR, and NL which had the lowest microbial content. There was no statistically significant difference between different microwave times of 30, 45 and 60 seconds. In conclusion, all the level of microwave time significantly affected the microbial content of ready to eat foods while the specified storage time didn't significantly affect the microbial content of the ready to eat foods. Restaurants varied in their compliance with the international standards tested against them. Nevertheless, most of the Samples collected were

compliant with the satisfactory classification of the Hong Kong (HK), New South Wales, Australia (NSW) and International Commission on Microbiological Specifications for Foods (ICMSF) standards for the microbial content of ready to eat foods.



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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**KESAN MEMEGANG DAN MEMANASKAN SEMULA MASA
MENGUNAKAN GELOMBANG MIKRO PADA BEBAN MIKROB YANG
SEDIA UNTUK MENGGUNAKAN MAKANAN DI RESTORAN TERPILIH DI
SELANGOR MALAYSIA**

Oleh

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Oleh kerana terdapat perubahan dalam gaya hidup masyarakat, permintaan makanan sedia makan (RTE) semakin meningkat di seluruh dunia. Di Malaysia, urbanisasi telah mempengaruhi bagaimana dan di mana masyarakat mendapatkan makanan mereka. Makan di luar telah menjadi sebahagian daripada budaya masyarakat di Malaysia dan dengan ini menjadi satu keperluan untuk mengkaji kualiti makanan RTE yang dihidang di restoran tempatan. Objektif kajian ini adalah untuk mengkaji kesan masa penyimpanan dan pemanasan gelombang mikro terhadap kandungan mikro makanan RTE yang disediakan dan dihidangkan di restoran tempatan. Sejumlah 120 sampel telah dianalisis untuk menilai kesan masa penyimpanan dan terhadap kandungan mikro sampel makanan. Empat sampel bagi setiap jenis makanan dari setiap restoran diteliti diuji secara mikrobiologi bagi bakteria *Coliforms* dan *Escherichia coli*. Set sampel yang lain, 120 sampel daripada restoran yang sama telah diambil untuk menguji kesan masa pemanasan gelombang mikro yang berbeza terhadap kandungan mikro makanan. Walau bagaimanapun, sampel ini dianalisis setelah menjalani masa gelombang mikro pada tahap yang berbeza; iaitu pada 0 saat, 30 saat, 45 saat dan 60 saat. Daripada sampel yang dikumpul iaitu Nasi Putih (PR), Roti Canai (RC), Ayam Goreng (FC), Nasi Goreng Ayam (CFR), Mee Goreng (FN), dan Nasi Lemak (NL); NL mempunyai kandungan mikro tertinggi bagi kandungan mikro bagi kedua-dua kandungan *Coliform* iaitu dari 3.6 sehingga lebih kurang 1100 MPN/g. Walau bagaimanapun, walau terdapat peningkatan dari segi jumlah mikroorganisma di dalam sampel yang diuji, masa penyimpanan tidak mempunyai kesan signifikan terhadap kandungan mikro bagi mana-mana sampel yang diuji, kecuali bagi FN dan NL dimana masa penyimpanan secara signifikan mempengaruhi beban mikro. Kesan masa gelombang mikro terhadap beban mikro adalah signifikan. Ini dapat dilihat pada kandungan TPC bagi semua sampel kecuali pada RC, PR dan NL dimana ketiga-tiga ini mempunyai kandungan mikro yang

paling rendah. Tiada perbezaan signifikan dapat dilihat diantara masa gelombang mikro yang berbeza iaitu pada 30, 45 dan 60 saat. Kesimpulannya, kesemua tahap masa gelombang mikro mempengaruhi kandungan mikrob makanan sedia makan secara signifikan. Terdapat perbezaan dari segi pematuhan restoran terhadap piawaian antarabangsa yang diuji terhadap mereka. Namun begitu, hampir semua sampel yang dikumpul mematuhi klasifikasi memuaskan piawaian Negara Hong Kong (HK), New South Wales, Australia (NSW) dan Suruhanjaya Antarabangsa Spesifikasi Mikrobiologi untuk Makanan (ICMSF) bagi kandungan mikrob makanan sedia makan.



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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 Master of Science. The members of the Supervisory Committee were as follows:

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TABLE OF CONTENTS

		Page
ABSTRACT		i
ABSTRAK		iii
ACKNOWLEDGEMENTS		v
APPROVAL		vi
DECLARATION		viii
LIST OF TABLES		xiii
LIST OF FIGURES		xiv
LIST OF ABBREVIATIONS		xvi
CHAPTER		
1	INTRODUCTION	1
	1.1 Background	1
	1.2 Problem Statement	2
	1.3 Objectives	3
2	LITERATURE REVIEW	4
	2.1 Foodborne Illness	4
	2.2 Foodborne Illnesses in Developed Countries	4
	2.3 Foodborne Illnesses in Developing Countries	5
	2.4 Foodborne Illnesses in Malaysia	5
	2.5 Food Quality Indicators	6
	2.5.1 Aerobic Plate Count	6
	2.5.2 Coliforms	7
	2.5.3 Fecal Coliforms	8
	2.5.4 <i>Escherichia coli</i>	8
	2.6 Food Service Establishment as Food Safety Concern	9
	2.7 Food Safety Knowledge and Attitudes	10
	2.8 Food Safety	11
	2.9 Food Applications of Microwave	12
3	METHODOLOGY	13
	3.1 General Methodology Flow Chart	13
	3.2 Sample Collection	13
	3.3 Microbiological Analysis	14
	3.3.1 Total Colony Count	14
	3.3.2 Coliforms	14
	3.3.3 Fecal Coliforms	15
	3.3.4 <i>Escherichia coli</i>	15
	3.4 Microbial Quality of Ready-to-Eat (RTE) Foods at Different Holding Times	15
	3.5 Microbial Quality of Ready-to-Eat (RTE) Foods at Different Microwave Re-Heating Times	16
	3.6 Compliance of Different Restaurants with the Standard Microbial Criteria for Ready-to-Eat (RTE) Foods	16
	3.7 Statistical Analysis	17

4	RESULTS AND DISCUSSION	18
4.1	Microbial Quality of Ready-to-Eat (RTE) Foods at Different Holding Times	18
4.1.1	Microbial Quality of Plain Rice (PR) at Different Holding Times	19
4.1.2	Microbial Quality of Fried Chicken (FC) at Different Holding Times	19
4.1.3	The Microbial Quality of Chicken Fried Rice (CFR) at Different Holding Times	20
4.1.4	The Microbial Quality of Fried Noodles (FN) at Different Holding Times	20
4.1.5	Microbial Quality of Nasi Lemak (NL) at Different Holding Times	21
4.1.6	Microbial Quality of Roti Canai (RC) at Different Holding Times	21
4.1.7	The Effect of Holding Times on TPC and Coliform Load in RTE Foods	21
4.1.7.1	The Effect of Holding Times on the TPC and Coliform Load of Plain Rice (PR)	23
4.1.7.2	The Effect of Storage Time on the Microbiological Content of Fried Chicken (FC)	25
4.1.7.3	The Effect Of Storage Time on the Microbiological Content of Chicken Fried Rice (CFR)	27
4.1.7.4	The Effect of Storage Time on the Microbiological Content of Fried Noodle (FN)	28
4.1.7.5	The Effect of Storage Time on the Microbiological Content of Nasi Lemak (NL)	30
4.1.7.6	The Effect of Storage Time on the Microbiological Content of Roti Canai (RC)	31
4.2	Microbial Quality of Ready-to-Eat (RTE) foods at Different Microwave Re-Heating Times	32
4.2.1	Microbial Quality of Plain Rice (PR) at Different Microwave Re-Heating Times	33
4.2.2	The Effect of Microwave Time on the Microbiological Content of Fried Chicken (FC)	35
4.2.3	The Effect of Microwave Time on the Microbiological Content of Chicken Fried Rice (CFR)	37
4.2.4	The Effect of Microwave Time on the Microbiological Content of Fried Noodles (FN)	39
4.2.5	The Effect of Microwave Time on the Microbiological Content of Nasi Lemak (NL)	41

4.2.6	The Effect Of Microwave Time on the Microbiological Content of Roti Canai (RC)	42
4.3	Classification of Restaurants According to the Quality of Their RTE Foods	43
5	CONCLUSION AND RECOMMENDATIONS	50
	REFERENCES	52
	APPENDICES	63
	BIODATA OF STUDENT	64



LIST OF TABLES

Table		Page
2.1	Number of Cases and Incidence Rate of Food and Waterborne Diseases in Malaysia from 2009 to 2013	6
4.1	TPC, Coliform and <i>E. coli</i> Load in Six Types of RTE Foods at Different Holding Times (0, 1, 2, 3 hours)	18
4.2	One-way Anova of Microbial (TPC) Content in RTE Foods Against Storage Time	22
4.3	One-way Anova of Microbial (Coliform) Content in RTE Foods Against Storage Time	23
4.4	TPC and Coliform Load of in Six Types of RTE Foods at Different Microwave Re-Heating Times (0, 30, 45 and 60 minutes)	33
4.5	Comparison of Total TPC Content of Samples from Restaurant A to Three Different Guidelines	44
4.6	Comparison of Total TPC Content of Samples from Restaurant B to Three Different Guidelines	45
4.7	Comparison of Total TPC Content of Samples from Restaurant C to Three Different Guidelines	46
4.8	Comparison of Total TPC Content of Samples from Restaurant D to Three Different Guidelines	47
4.9	Comparison of Total TPC Content of Samples from Restaurant E to Three Different Guidelines	48
4.10	One-way Anova of microbial (TPC) content in RTE Foods against microwave reheating time	63
4.11	One-way Anova of microbial (coliform) content in RTE Foods against microwave reheating time	63

LIST OF TABLES

Figure		Page
3.1	Methodology Flow Chart	13
4.1	Mean Plot of TPC Against Holding Time for Plain Rice	24
4.2	Means Plot of Coliform Against Holding Time of Plain Rice	25
4.3	Mean Plot of TPC Against Holding Time for Fried Chicken	26
4.4	Means Plot of Coliform Against Holding Time of Fried Chicken	26
4.5	Means Plot of TPC Against Holding Time for Chicken Fried Rice	27
4.6	Means Plot of Coliform Against Holding Time for Chicken Fried Rice	28
4.7	Means Plot of TPC Against Holding Time for Fried Noodles	29
4.8	Means Plot of Coliform Against Holding Time for Fried Noodles	29
4.9	Means Plot of TPC Against Holding Time for Nasi Lemak	30
4.10	Means Plot of Coliform Against Holding Time for Nasi Lemak	31
4.11	Means Plot of TPC Against Holding Time for Roti Canai	32
4.12	Means Plot of Microwave Time Against TPC Levels of Plain Rice	34
4.13	Means Plot of Microwave Time Against Coliform Levels of Plain Rice	35
4.14	Means Plot of Microwave Time Against TPC Levels Of Fried Chicken	36
4.15	Means Plot of Microwave Time Against Coliform Levels of Fried Chicken	37
4.16	Means Plot of Microwave Time Against TPC Levels of Chicken Fried Rice	38
4.17	Means Plot of Microwave Time Against Coliform Levels of Chicken Fried Rice	39
4.18	Means Plot of Microwave Time Against TPC Levels of Fried Noodles	40
4.19	Means Plot of Microwave Time Against Coliform Levels of Fried Noodles	40

4.20	Means Plot of Microwave Time Against TPC levels of Nasi Lemak	41
4.21	Means Plot of Microwave Time Against TPC Levels of Nasi Lemak	42



LIST OF ABBREVIATIONS

UPM	Universiti Putra Malaysia
ICMSF	International Commission on Microbiological Specifications for Foods
FDA	Food and Drug Administration
RTE	Ready to Eat
CFU	Colony Forming Units
APC	Aerobic Plate Count
MPN	Most Probable Number
EC	Escherichia coli
WHO	World Health Organization
IID	Intestinal Infectious Disease
EU	European Union
CDC	Centers for Disease Control and Prevention
USA	United State America
STECs	Shiga Toxin-Producing E. coli
SPC	Standard Plate Count
WA	Water Activity
NRTE	Not Ready To Eat
UHT	Ultra-Heat Treatment
MW	Microwave
FCC	Federal Communication Commission
EM	Electromagnetic
TPC	Total Plate count
TC	Total Coliform
L-EMB	Levine-eosin Methylene Blue
DRBC	Dichloran Rose Bengal Chloramphenicol
MEA	Malt Extract Agar
PDA	Potato Dextrose Agar
RC	Roti Canai
FN	Fried Noodles
NL	Nasi Lemak
PR	Plain Rice
FC	Fried Chicken
CFR	Chicken Fried Rice
HHS	US Department of Health and Human Services

CHAPTER 1

INTRODUCTION

1.1 Background

Foodborne diseases in developed and developing countries present a serious challenge to public health. The occurrence rates of these diseases have been reported to be in the order of 1,210 cases per 100,000 population in France, 2,600 cases per 100,000 population in the United Kingdom, and more than 25,000 cases per 100,000 population in Australia and the United States (Teisl and Roe, 2010). Malaysia, however, reported a low rate of 48 cases per 100,000 population. The cases reported in Malaysia resulting from foodborne illnesses typically go unreported since many issues need to be tended to first before conveying to a specialist (Soon et al., 2011). Accordingly, this could indicate that the real number of cases are likely to be much higher in Malaysia (Abdul-Mutali et al., 2015a).

The advancements in food production and technology coupled with the increasingly busy lifestyle of people have resulted in significant growth in the food services industry. Studies in both developing and developed countries have shown that the majority of reported foodborne diseases originate in food service establishments (Nyamari, 2013). Indeed, food-related illnesses do not only affect the health and well-being of people but also results in significant economic implications and consequences for countries, communities, families, individuals, including businesses within the food services industry (Lin, 2010; Almanza and Nesmith, 2004).

Foods are sometimes contaminated with microorganisms during and after handling. Moreover, hygienic conditions are poor when foods are produced in non-industrial establishments, mainly due to improper or poor hygiene practices. Previous research has indicated that unhygienic practices of a food handler during the process of food preparation significantly contributes towards the overall contamination of the food through direct contact as well as through contact with equipment such as knife scabbards and the clothing of operatives, etc. Therefore, good hygienic practices and training of those people involved in the different stages of handling food are crucial to safeguarding against all forms of foodborne illnesses. For example, this may include the stages associated with food preparation, processing and serving of meals which are all critical steps in the food chain (Sospedera et al., 2013). Furthermore, constant monitoring and evaluation of the microbial quality of RTE foods served at restaurants or foodservice establishments are equally important.

The detection of pathogens in ready-to-eat (RTE) food indicates a significant risk of foodborne illness, however, indicator microorganisms have been used to indicate the general hygienic conditions during food production or handling. The presence of

pathogens in food, while not indicated by the level of Total Plate Count (TPC), a high level of TPC is an important indicator as this can help to identify poor quality food. On the other hand, a high level of coliform counts reflects the unsanitary conditions or poor hygienic practices during food production, handling or poor quality associated with the procedures used to minimise microbial contamination.

RTE foods are fast becoming a popular choice for busy people and consumers are increasingly attracted to these foods given their convenience and availability at food service establishments. RTE foods are characterised as food that is eatable without additional washing, cooking, or extra preparation by the customer or by the food establishment and is required to be eaten in its present state (Garg et al., 2016; Smulders, 2013). In Malaysia, RTE foods are many. For instance, they can be cooked foods consumed at restaurants, fast food meals provided by vendors or street hawkers or packaged food material like crackers, fresh fruits and vegetables served at local convenience stores or hypermarkets.

Many studies have been undertaken on RTE foods in Malaysia such as vegetables, peanut sauce, fish-balls, fish-cakes, salads, satay and accompanying cucumber slices (Arumugaswamy et al., 1995). Also, Jamali and Thong (2014) investigated salads, vegetables, cooked chicken, fried or boiled eggs, cooked seafood, beverage and packed lunch meals. A study by Jamali et al., 2013 tested a large variety of RTE foods namely; beverages, fried chicken, chicken satay, chicken sausages, chicken burger, breaded chicken meatballs, hard-boiled eggs with the shell removed, fried eggs and egg tarts, stir-fried eggs and burger beef, sushi, fried fish, fish roll, barbecue cuttlefish, Malaysian salad with vinegar, potato salad with mayonnaise, fruit salads, raw bean sprout, blanched long bean, raw lettuce, raw cucumber, raw tomato and raw cabbage, noodles, steam rice, chicken soups and custard. In a separate study, Lee et al., 2009 examined commercial cereal products.

1.2 Problem Statement

Eating habit among Malaysian showed a changing pattern from home and family-based habits to eating-out (Ali & Abdullah, 2017), thus making RTE foods becoming popular choices. As RTE foods are consumed with no further processing, and there is a microbiological risk associated with their consumption, the safety control of the RTE food is very important.

In this context, food handlers play a key role. Studies have found that the level of food hygiene knowledge and practices among food handlers working at various food service establishments in Malaysia is unsatisfactory. Furthermore, RTE food contamination (Zin et al., 2017), and insufficient food handler hygiene (Zin et al., 2017,) have been reported in school canteens (Tan et al., 2013) and military canteens (Lee et al., 2012). These findings hypothetically highlight that RTE food and food safety challenges are significantly affected by poor hygienic practices among food handlers. Therefore, this

study has used quality and safety indicator microorganisms that could indicate inadequate hygiene and sanitation practices during RTE food production at restaurants.

Time and temperature control have been used as food control measures based on the USFDA code and other relevant guidelines (USFDA, 2009; Sizer et al., 2012, Berdanier et al., 2016). As an alternative measure of using temperature control, holding time before consumption is increasingly being used to minimise the risk of food poisoning and providing more practical food safety control measures for RTE foods. Generally, freshly cooked foods are held to a holding time in thermos insulators or in food warmer containers that are supposed to maintain the temperature of the food during the period of sale. Despite the known rules for holding times (four hours above 65 °C), sufficient time and temperature monitoring by respective food handlers are crucial to ensure that these control measures are implemented. Regarding the issues surrounding poor hygienic knowledge and practices among food handlers, the common gap that is found remains on holding time practices for RTE foods in Malaysia and their association with microbial safety. Limited studies have focussed on time control at room temperature. Therefore, the present study will determine the microbial safety of RTE foods at different holding times based on the common practices in RTE food production in Malaysian restaurants. Corresponding to the holding time, reheating RTE foods using microwave ovens has also become common practice in restaurants. Microwave reheating has demonstrated an acceptable safety record when applying the following procedures (75 °C for 15 sec).

However, despite Malaysia having strict food regulations and standards for the microbial safety of RTE foods, standard criteria for certain types of RTE foods are still inadequate. Considerable more work is required to establish baseline data that can be used to review or evaluate the standard according to scientific means. In this context, the compliance of six RTE foods is determined based on 3 available microbial standard guidelines from NSW (New South Wales, Australia), Hong Kong and the ICMSF (International Commission on Microbiological Specifications for Foods). The mapping of criteria, in this case, will reveal the critical points of microbial quality of the RTE foods sold in Malaysian restaurants. Moreover, the baseline elements will facilitate towards the development of comprehensive microbiological standards for RTE foods from a Malaysian perspective.

1.3 Objectives

The objectives of this research are as follows:

1. To determine the microbial quality of ready to eat foods at different holding temperatures
2. To assess the microbial quality of selected ready to eat foods at different microwave reheating time
3. To establish the compliance of selected ready to eat foods with standard microbiological criteria for RTE foods

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