



**UNIVERSITI PUTRA MALAYSIA**

**MICROBIOLOGICAL AND CHEMICAL QUALITY OF *KEROPOK*  
*LEKOR* DURING PROCESSING AND STORAGE**

**NOR KHAIZURA BINTI MAHMUD @**

**AB. RASHID**

**FSTM 2008 3**

**MICROBIOLOGICAL AND CHEMICAL  
QUALITY OF *KEROPOK LEKOR* DURING  
PROCESSING AND STORAGE**

**NOR KHAIZURA BINTI MAHMUD @  
AB. RASHID**

**MASTER OF SCIENCE  
UNIVERSITI PUTRA MALAYSIA**

**2008**



**MICROBIOLOGICAL AND CHEMICAL QUALITY OF *KEROPOK*  
*LEKOR* DURING PROCESSING AND STORAGE**

**By**

**NOR KHAIZURA BINTI MAHMUD @ AB. RASHID**

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

**March 2008**



*Specially dedicated to my soul mate: Ismail Fitry  
my lil' caliph: Uzair Aqil  
my lovely parents: mummy and ayah  
for their constant prayer for my success*



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

**MICROBIOLOGICAL AND CHEMICAL QUALITY OF *KEROPOK*  
*LEKOR* DURING PROCESSING AND STORAGE**

By

**Nor Khaizura Binti Mahmud @ Ab. Rashid**

**March 2008**

**Chairman : Associate Professor Zaiton Hassan, PhD**

**Faculty : Food Science and Technology**

*Keropok lekor* is an important fish product in Malaysia. The customers' demands for *keropok lekor* have been increasing. This study was conducted to analyze the microbiological and chemical quality of *keropok lekor* in every stage of its processing, namely mincing, mixing, kneading, boiling and cooling. Subsequently, this study was also undertaken in an attempt to determine the effectiveness of post processing treatment on *keropok lekor* in order to prolong its shelf life. The method used to analyze the microbiological quality is known as the direct plate counts for the total plate counts (TPC), psychrotrophic, yeasts and molds, mesophilic sporeformer, *Staphylococcus aureus*, total coliform and fecal coliform counts. Simple biochemical test was carried out to identify the presumptive bacteria present in *keropok lekor* processing. Chemical quality was analyzed on the total volatile bases (TVB) and trimethylamine (TMA), using Conway microdiffusion method, and biogenic amines was done using the High Performance Liquid Chromatography (HPLC). The post-processing treatments on *keropok lekor* were exposing *keropok lekor* to UV light for 15 or 30 min, either coated with different concentrations of ascorbic acid (500, 1000 or 1500



ppm) or dipped in hot oil for 3, 6 or 9 s, and stored at the room temperature for 7 d or at chill temperature ( $4\pm 1^{\circ}\text{C}$ ) for 14 d. When processing *keropok lekor*, the boiling of *keropok lekor* at  $100^{\circ}\text{C}$  for 10 min reduced the TPC ( $4.38\pm 0.47 \log_{10}$  cfu/g), psychrotrophic counts ( $2.00 \pm 0.00 \log_{10}$  cfu/g), mesophilic sporeformer counts ( $1.26 \pm 0.34 \log_{10}$  cfu/g) and total coliform counts ( $1.71\pm 0.51 \log$  MPN/g) significantly ( $p>0.05$ ). However, the microbial counts were found to increase significantly ( $p<0.05$ ) after the cooling process, except for the yeast and mold counts and *S. aureus* counts. The presumptive predominant microorganisms, isolated before the boiling stage, were members of the *Enterobacteriaceae* family and those belonging to *Pseudomonas*, *Vibrio*, *Staphylococcus*, *Bacillus* and *Micrococcus* genus. After the boiling stage, the presumptive predominant microorganisms were members of *Enterobacteriaceae* family and those belonging to *Micrococcus*, *Bacillus*, *Staphylococcus* and *Aerococcus* genus. As for the chemical quality, TVB and TMA levels were indicated to significantly decrease ( $p<0/05$ ) after boiling from 7.29 to 4.68 mg/ 100g and 3.38 to 1.81 mg/ 100g, respectively, but not for the putrescine, cadaverine and histamine levels. Before the boiling stage, presumptive microorganisms producing putrescine, cadaverine and histamine were members of the *Enterobacteriaceae* family, as well as members of *Staphylococcus*, *Pseudomonas* and *Micrococcus* genus. Members of the genus *Pseudomonas*, which produce biogenic amines, were not isolated from *keropok lekor* after the boiling stage. The post-processing treatment which was applied on *keropok lekor* was found to enhance both its quality and shelf life. The results showed that exposing *keropok lekor* to UV light for 15 min and dipping it in hot oil for 9 s had extended the shelf life of this snack for 5 d when

stored at the room temperature, and for 14 d when stored at  $4\pm 1^{\circ}\text{C}$ . This post processing treatment had also caused a significant reduction in TPC, psychrotrophic count, yeasts and molds count, TVB, as well as TMA and putrescine, cadaverine and histamine level. On the contrary, ascorbic acid was not as effective in increasing the shelf life of *keropok lekor* or in reducing TVB, TMA and putrescine, cadaverine and histamine level, as compared to dipping it in hot oil.

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

**KUALITI MIKROBIOLOGI DAN KIMIA BAGI KEROPOK LEKOR  
SEMASA PEMROSESAN DAN PENYIMPANAN**

Oleh

**Nor Khaizura Binti Mahmud @ Ab. Rashid**

**March 2008**

**Pengerusi : Professor Madya Zaiton Hassan, PhD**

**Fakulti : Sains dan Teknologi Makanan**

Keropok lekor merupakan produk hasilan ikan yang penting di Malaysia. Permintaan pengguna terhadap keropok lekor semakin meningkat. Kajian ini dijalankan untuk menganalisis kualiti keropok lekor dari aspek mikrobiologi dan kimia pada setiap peringkat dalam pemprosesan keropok lekor. Proses tersebut terdiri daripada mencincang isi ikan, menggaul, menguli, merebus dan menyejukkan keropok lekor. Seterusnya, kajian ini juga dilakukan untuk menentukan keberkesanan rawatan selepas pemprosesan ke atas keropok lekor dengan tujuan untuk memanjangkan jangka hayat produk. Kaedah yang digunakan untuk menganalisis kualiti mikrobiologi adalah pengiraan terus dari plat bagi total kiraan mikroorganisma (TPC), kiraan bakteria psychrotrophic, kiraan yis dan kulat, bakteria mesophilic yang menghasilkan spora, *Staphylococcus aureus*, total kiraan coliform dan fecal coliform. Ujian asas biokimia juga dijalankan untuk mengenalpasti bacteria yang mungkin hadir semasa pemprosesan keropok lekor. Kualiti kimia dianalisis melalui total volatile bases (TVB) dan trimethylamine (TMA) dengan kaedah Conway microdiffusion dan biogenic amine dengan kaedah kromatografi cecair prestasi





tinggi (HPLC). Rawatan yang digunakan selepas pemprosesan dikenakan ke atas keropok lekor adalah dengan mendedahkan keropok lekor kepada cahaya UV selama 15 atau 30 minit dan seterusnya disalut dengan asid askorbik yang berkepekatan berbeza (500, 1000 atau 1500 ppm) atau dicelup ke dalam minyak panas selama 3, 6 atau 9 saat dan disimpan pada suhu bilik selama 7 hari atau suhu sejuk ( $4\pm 1^{\circ}\text{C}$ ) selama 14 hari. Semasa pemprosesan keropok lekor, proses merebus keropok lekor pada  $100^{\circ}\text{C}$  untuk 10 min didapati dapat mengurangkan kiraan TPC ( $4.38\pm 0.47 \log_{10} \text{cfu/g}$ ), kiraan bakteria psychrotrophic ( $2.00 \pm 0.00$ ), kiraan bakteria mesophilic yang menghasilkan spora ( $1.26 \pm 0.34$ ) and total kiraan coliform ( $1.71\pm 0.51 \log \text{MPN/g}$ ) dengan signifikan ( $p<0.05$ ). Namun demikian, kiraan mikroorganisma meningkat semula dengan signifikan ( $p<0.05$ ) selepas proses menyejukkan keropok lekor kecuali kiraan yis dan kulat dan *S. aureus*. Mikroorganisma pradominan yang dapat dipencilkan sebelum proses merebus adalah daripada famili *Enterobacteriaceae* dan juga daripada genus *Pseudomonas*, *Vibrio*, *Staphylococcus*, *Bacillus* dan *Micrococcus*. Selepas proses merebus, mikroorganisma pradominan adalah daripada famili *Enterobacteriaceae* dan daripada genus *Micrococcus*, *Bacillus*, *Staphylococcus* dan *Aerococcus*. Bagi kualiti kimia, paras TVB dan TMA menunjukkan pengurangan yang signifikan ( $p<0.05$ ) selepas proses merebus daripada 7.29 kepada 4.68 mg/ 100g dan 3.38 kepada 1.81 mg/ 100g, secara berturutan, tetapi tiada pengurangan yang signifikan bagi paras putrescine, cadaverine dan histamine. Mikroorganisma pradominan yang boleh menghasilkan putrescine, cadaverine dan histamine sebelum proses merebus didapati terdiri daripada famili *Enterobacteriaceae* dan juga daripada genus *Staphylococcus*, *Pseudomonas* dan

*Micrococcus*. Tiada genus *Pseudomonas* yang didapati boleh menghasilkan putrescine, cadaverine dan histamine dapat dipencilkan selepas proses merebus. Rawatan selepas pemprosesan yang dikenakan ke atas keropok lekor didapati dapat meningkatkan kualiti dan jangka hayat keropok lekor. Keputusan menunjukkan keropok lekor yang didedahkan kepada cahaya UV selama 15 minit dan dicelup ke dalam minyak panas selama 9 saat dapat memanjangkan jangka hayat keropok lekor kepada 5 hari apabila disimpan pada suhu bilik dan 14 hari apabila disimpan pada suhu  $4\pm 1^{\circ}\text{C}$ . Rawatan selepas pemprosesan ini juga menunjukkan pengurangan secara signifikan pada TPC, kiraan bakteria psychrotrophic, kiraan yis dan kulat, paras TVB, TMA dan putrescine, cadaverine dan histamine. Asid askorbik didapati kurang berkesan dalam memanjangkan jangka hayat keropok lekor atau mengurangkan paras TVB, TMA dan juga putrescine, cadaverine dan histamine jika dibandingkan dengan mencelup keropok lekor dalam minyak panas.

## ACKNOWLEDGEMENTS

Alhamdulillahirabbil‘alamin. I would like to start off my words here by thanking Allah SWT, The Merciful and The Sustainer, for His mercy, love, and strength granted for me so that I have been able to finish this thesis. May the peace and blessings of Allah SWT be upon Prophet Muhammad SAW.

Besides, I fell so indebted to many people who played a part in my thesis accomplishment. Without them, this ‘little masterpiece’ would have never been done as better as I just did. Thus, let me appreciate them all to express my gratitude to them.

First and foremost, I would like to express my deep sense of gratitude to my supervisor, Assoc. Prof. Dr. Zaiton Hassan for her excellent guidance, advice and assistance in this research. Her instructions were always constructive and positive, guiding me in completing this thesis with a thorough understanding of the problem. Special gratitude goes to my thesis committee member, Prof. Dr. Jamilah Bakar for her excellent advice and guidance. My grateful acknowledgements are also given to Prof. Dr. Gulam Rusul Rahmat Ali, for his insightful ideas and suggestions in this research.

Special appreciation is extended to Puan Jamilah, En. Zulkifli, En. Halim and Hj Ismail for their technical assistance, and I also would like to thank everyone in the microbiology lab who had helped me a lot during my bench work. I would like to mention a few other colleagues for their support, encouragement and



friendship; they are Yousr, Aniza Zuniffa and Suwaibah. Thanks to all my friends, it has been a pleasure studying and working with all of you.

My deepest gratitude goes to my family, mummy, ayah, brothers and sisters and my in-laws. Without their prayers and supports, all this would have been very difficult. I owe them eternal gratitude. The most important word of appreciation goes to my best buddy and beloved husband, Ismail Fitry, who had endured this long process with me, and who has always been offering support and love to me. Last but not least, my cute little one, Uzair Aqil who is always my pillar of strength.

To everybody who had ever helped me but I could not mention your name one by one, I want to say thank you. It is hardly possible for me to mention you all by name. Once again, thank you. May Allah bless you.

Finally, it is needless to say that my thesis is still far from being perfect even though I have made my best. Though it is so, I expect that this thesis contribute benefits to all readers and those who are involved in this.

I certify that an Examination Committee met on **date of viva** to conduct the final examination of Nor Khaizura Binti Mahmud @ Ab. Rashid on her Master of Science thesis entitled, “Microbiological and Chemical Quality of Keropok Lekor during Processing and Storage,” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Putra Malaysia (Higher Degree) Regulation 1981. The committee recommends that the candidate be awarded the relevant degree.

Members of the Examination Committee are as follows:

**Azizah Abdul Hamid, PhD**

Associate Professor  
Faculty of Food Science and Technology  
Universiti Putra Malaysia  
(Chairman)

**Fatimah Abu Bakar, PhD**

Associate Professor  
Faculty of Food Science and Technology  
Universiti Putra Malaysia  
(Internal Examiner)

**Nazamid Saari, PhD**

Associate Professor  
Faculty of Food Science and Technology  
Universiti Putra Malaysia  
(Internal Examiner)

**Mohd Khan Ayob, Ph.D.**

Associate Professor  
Faculty of Science and Technology  
Universiti Kebangsaan Malaysia  
Malaysia  
(External Examiner)

---

**HASANAH GHAZALI, PhD**

Professor and Deputy Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date:



This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. Members of the Supervisory Committee were as follows:

**Zaiton Hassan, PhD**

Associate Professor  
Faculty of Food Science and Technology  
Universiti Putra Malaysia  
(Chairman)

**Jamilah Bakar, PhD**

Professor  
Faculty of Food Science and Technology  
Universiti Putra Malaysia  
(Member)

**Gulam Rusul Rahmat Ali, PhD**

Professor  
School of Industrial Technology  
Universiti Sains Malaysia  
(Member)

---

**AINI IDERIS, Ph.D.**

Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 11 September 2008



## DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

---

NOR KHAIZURA BINTI MAHMUD @ AB. RASHID

Date:

## TABLE OF CONTENTS

<b>DEDICATION</b>	ii
<b>ABSTRACT</b>	iii
<b>ABSTRAK</b>	vi
<b>ACKNOWLEDGEMENTS</b>	ix
<b>APPROVAL</b>	xi
<b>DECLARATION</b>	xiii
<b>LIST OF TABLES</b>	xvii
<b>LIST OF FIGURES</b>	xx
<b>LIST OF APPENDICES</b>	xxi
<b>LIST OF ABBREVIATIONS</b>	xxii
<b>CHAPTER</b>	
1 <b>INTRODUCTION</b>	1
2 <b>LITERATURE REVIEW</b>	
2.1    Fish Products in Malaysia	5
2.2 <i>Keropok</i>	6
2.2.1    Processing of <i>Keropok Lekor</i>	9
2.2.2    The Role of the Processing Ingredients in <i>Keropok Lekor</i>	11
2.3    The Microbiological Quality of Fish Products	15
2.3.1    Microbial Contamination Sources	18
2.4    Chemical Quality of Fish Products	22
2.4.1    Total Volatile Bases (TVB)	23
2.4.2    Trimethylamine (TMA)	24
2.4.3    Biogenic Amines	26
2.5    Post-Processing Treatment of Processed Fish Products	28
2.5.1    Exposure to Ultraviolet Light	29
2.5.2    Coating with Ascorbic Acid	32
2.5.3    Dipping in Hot Oil	34
3 <b>MICROBIOLOGICAL AND CHEMICAL QUALITY           OF <i>KEROPOK LEKOR</i> DURING PROCESSING</b>	
3.1    Introduction	36
3.2    Materials and Methods	39
3.2.1    Samples	39
3.2.2    Proximate analysis	43
3.2.3    Microbiological Analysis	44
3.2.4    Physicochemical Analysis	45
3.2.5    Determination of Total Volatile Bases (TVB) and Trimethylamine (TMA)	47





3.2.6	Determination of Putrescine, Cadaverine and Histamine	49
3.2.7	Determination of Proteolytic bacteria, Putrescine, Cadaverine and Histamine Producers	52
3.2.8	Statistical Analysis	53
3.3	Results	53
3.3.1	Proximate composition	53
3.3.2	Microbiological quality of <i>keropok lekor</i> during processing	54
3.3.3	Internal temperature, pH and water activity ( $a_w$ ) of <i>keropok lekor</i> at different stages of processing	59
3.3.3	Chemical quality of <i>keropok lekor</i> during processing	61
3.4	Discussion	67
3.5	Conclusion	78

#### 4 **THE EFFECT OF UV LIGHT EXPOSURE COMBINED WITH EITHER ASCORBIC ACID OR HOT OIL ON MICROBIOLOGICAL AND CHEMICAL QUALITY OF *KEROPOK LEKOR***

4.1	Introduction	79
4.2	Materials and Methods	80
4.2.1	Materials	80
4.2.2	Preparation of the Samples	81
4.2.3	Preparation of the Coating Solution	81
4.2.4	Experimental Design	81
4.2.5	Microbiological Analysis	82
4.2.6	Physicochemical Analysis	83
4.2.7	Chemical Analysis	83
4.2.8	Statistical Analysis	83
4.3	Results	84
4.3.1	Effect of UV light exposure, combined with either ascorbic acid coating or dipping in hot oil, on microbiological and chemical quality of <i>keropok lekor</i> during storage at the room temperature	84
4.3.2	Effect of UV light exposure combined, with either ascorbic acid coating or hot oil dipping, on the microbiological and chemical quality of <i>keropok lekor</i> during storage at chilled (4°C) temperature	97
4.4	Discussion	110
4.5	Conclusion	120

5	<b>CONCLUSION AND RECOMMENDATIONS</b>	121
	<b>REFERENCES</b>	124
	<b>APPENDICES</b>	142
	<b>BIODATA OF STUDENT</b>	151
	<b>LIST OF PUBLICATIONS</b>	152



## LIST OF TABLES

<b>Table</b>		<b>Page</b>
2.1	Type and description of the Malaysian fish products	7
2.2	Microbiological spoilage of foods	16
3.1	Proximate analysis of <i>keropok lekor</i> (100 g)	53
3.2	Log reduction value of microbial counts after the boiling stage	56
3.3	Microbial counts during kneading, boiling and cooling stages	57
3.4	Presumptive of bacterial genus isolated at different stages of <i>keropok lekor</i> processing	58
3.5	Recovery of putrescine, cadaverine and histamine	63
3.6	Presumptive identification of isolates from Lysine Decarboxylase Agar (LDA), Arginine Decarboxylase Agar (ADA) and Niven's Agar plates from <i>keropok lekor</i> at different stages of processing (after kneading, boiling and cooling stages)	66
4.1	<i>Keropok lekor</i> exposure to UV light (15 or 30 min) combined with either ascorbic acid coating (500, 1000 or 1500 ppm) or dipped in hot oil (3, 6 or 9 s)	82
4.2	Total plate counts (TPC) of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min), either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at the room temperature for 7d	89
4.3	Psychrotrophic counts of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at the room temperature for 7d	90
4.4	Yeasts and molds counts of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at the room temperature for 7d	91



4.5	pH of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at the room temperature for 7d	92
4.6	Water activity ( $a_w$ ) of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at the room temperature for 7d	93
4.7	Total volatile bases (TVB) level in <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at the room temperature for 7d	94
4.8	Trimethylamine (TMA) level in <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at the room temperature for 7d	95
4.9	Putrescine, cadaverine and histamine level in <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at the room temperature for 7d	96
4.10	Total plate counts (TPC) of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at 4°C for 14 d	102
4.11	Psychrotrophic counts of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at 4°C for 14 d	103
4.12	Yeasts and molds counts of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at 4°C for 14 d	104

4.13	pH of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at 4°C for 14 d	105
4.14	Water activity ( $a_w$ ) of <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at 4°C for 14 d	106
4.15	Total volatile bases (TVB) level in <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at 4°C for 14 d	107
4.16	Trimethylamine (TMA) level in <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at 4°C for 14 d	108
4.17	Putrescine, cadaverine and histamine level in <i>keropok lekor</i> exposed to UV light (for 15 or 30 min) either coated with different concentrations of ascorbic acid (500, 1000 or 1500 ppm) or dipped in hot oil (for 3, 6 or 9 s) and stored at 4°C for 14 d	109



## LIST OF FIGURES

<b>Figure</b>		<b>Page</b>
3.1	Commercial processing of <i>keropok lekor</i> by the Gombak manufacturer	40
3.2	Deboning fish using a mechanical fish deboner	41
3.3	Mixing minced fish with other ingredients using a bowl mixer	41
3.4	Kneading the dough into long roll shape using a moving PVC roller to produce <i>keropok lekor</i>	42
3.5	Boiling <i>keropok lekor</i> using a boiler at 100°C	42
3.6	Cooling <i>keropok lekor</i> on a stainless steel table at ambient temperature	43
3.7	Total plate, psychrotrophic, yeasts and molds and mesophilic spore counts (log <sub>10</sub> cfu/g) of <i>keropok lekor</i> during mincing, mixing, kneading, boiling and cooling stages	55
3.8	<i>S. aureus</i> counts (log <sub>10</sub> cfu/g), coliforms and fecal coliform counts (log MPN/g) of <i>keropok lekor</i> during mincing, mixing, kneading, boiling and cooling stages	56
3.9	Internal temperature of <i>keropok lekor</i> during mincing, mixing, kneading, boiling and cooling stages	59
3.10	pH of <i>keropok lekor</i> during mincing, mixing, kneading, boiling and cooling stages	60
3.11	Water activity (a <sub>w</sub> ) of <i>keropok lekor</i> during mincing, mixing, kneading, boiling and cooling stages	60
3.12	Levels of the total volatile bases (TVB) and trimethylamine (TMA) in <i>keropok lekor</i> after kneading, boiling and cooling stages	61
3.13	Levels of putrescine, cadaverine and histamine in <i>keropok lekor</i> after kneading, boiling and cooling stages	62
3.14	Log <sub>10</sub> cfu/g of micro organisms producing proteolytic bacteria, putrescine, cadaverine and histamine in <i>keropok lekor</i> at after kneading, boiling and cooling stages	65

## LIST OF APPENDICES

Appendix		Page
A	Formulation of <i>keropok lekor</i>	142
B	Biochemical test Identification test of Gram positive bacteria	143
B1	Identification test of Gram negative bacteria	144
C	Solution preparation for TVB and TMA analysis	145
D	Calculation for TVB and TMA value	146
E	Figure E. Chromatogram of biogenic amine standards (Retention time: Putrescine: 7.659, Cadaverine: 8.175, Histamine: 12.349, remaining benzoyl chloride: 12.746)	147
F	Figure F1. Putrescine standard curve (0-50 ppm)	148
	Figure F2. Cadaverine standard curve (0-50 ppm)	149
	Figure F3. Histamine standard curve (0-50 ppm)	150

## LIST OF ABBREVIATIONS

AA	Ascorbic acid
ANOVA	Analysis of Variance
$a_w$	water activity
g	Gram
HO	Hot oil
HPLC	High Performance Liquid Chromatography
ICMSF	International Commission on Microbiology Specifications for Foods
mg	Milligram
min	Minute
MPN	Most Probable Number
MSG	Monosodium glutamate
nm	Nanometer
ppm	Part per million
s	Second
TCA	Trichloroacetic Acid
TMA	Trimethylamine
TPC	Total Plate Count
TVB	Total Volatile Basic
UV	Ultraviolet





## CHAPTER 1

### GENERAL INTRODUCTION

The production of *keropok lekor* is one of the important traditional fish product industries in Malaysia. It is a popular snack food, not only in Malaysia but also in the Association of South East Asian Nations or ASEAN (Yu, 1992; Yeap and Tan, 2002). *Keropok lekor* is made from minced fish which is mixed with sago or tapioca flour. The processing of *keropok lekor* involves mainly five stages; these include mincing the fish meat, mixing the minced fish with other ingredients, kneading the dough, boiling and cooling before it is packed. This product can be easily found at night markets, hawker stalls and also most of the school canteens. *Keropok lekor* is usually served as an appetizer or a snack with special local-made chilli sauce.

The processing of *keropok lekor* is considered as labour-intensive, and this is usually carried by small and medium industries with little mechanization. The ingredients used in processing of *keropok lekor* are mostly according to the traditional recipes. However, the method used in its production has been improved, mainly with an addition of the machinery used in the processing. The mechanism in the processing is crucial in order to fulfil the increasing demand for *keropok lekor* in today's market. Nevertheless, a lot of manual handling is still widely practised in the processing of *keropok lekor*.

