



UNIVERSITI PUTRA MALAYSIA

**CHARACTERISATION OF LOCAL IKAN PEKASAM AND DEVELOPMENT
OF A PROCESS FOR PRODUCTION OF IKAN PEKASAM FROM
BLACK POMFRET (*Parastromateus niger* BLOCH)**

EZZAT BINTI MOHAMAD AZMAN

FSTM 2014 12



**CHARACTERISATION OF LOCAL *IKAN PEKASAM* AND DEVELOPMENT
OF A PROCESS FOR PRODUCTION OF *IKAN PEKASAM* FROM
BLACK POMFRET (*Parastromateus niger* BLOCH)**

By

EZZAT BINTI MOHAMAD AZMAN

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

July 2014

COPYRIGHT

All material contained within the thesis, including without limitation text, logos, icons, photographs and all other artwork, is copyright material of Universiti Putra Malaysia unless otherwise stated. Use may be made of any material contained within the thesis for non-commercial purposes from the copyright holder. Commercial use of any material may only be made with the express, prior, written permission of Universiti Putra Malaysia.

Copyright© Universiti Putra Malaysia



DEDICATION

*Special Dedicated to my Beloved Husband and Daughter
for their Support and Unconditional Love*



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

**CHARACTERISATION OF LOCAL *IKAN PEKASAM* AND
DEVELOPMENT OF A PROCESS FOR PRODUCTION OF *IKAN PEKASAM*
FROM BLACK POMFRET (*Parastromateus niger* BLOCH)**

By

EZZAT BINTI MOHAMAD AZMAN

July 2014

Chairman : Professor Hasanah Mohd Ghazali, PhD
Faculty : Food Science and Technology

Ikan pekasam is a fermented fish product produced in Malaysia. It is usually made from freshwater fish, and the main source of carbohydrate for the fermentation process is ground roasted rice. In this study, the sensory and physicochemical properties including pH, titratable acidity, salt concentration, amino acids, biogenic amines, *trans*- and *cis*-urocanic acid (UCA), and organic acids of 15 commercially available samples were determined. The samples comprised *ikan pekasam* made from two types of commonly used freshwater fish, namely *lampam jawa* (*Puntius gonionotus*) and black tilapia (*Oreochromis mossambicus*), that had undergone either natural or acid-assisted fermentation. Acid-assisted fermented samples are those that included either tamarind pulp (*Tamarindus indica*) or *Garcinia atroviridis* dried slices as an ingredient in the fermentation process. The result showed that there were significant differences ($p \leq 0.05$) in pH values, total UCA (*trans*- plus *cis*-UCA) and *cis*-UCA contents between naturally and acid-assisted fermented *ikan pekasam* samples. However, there were many similarities including titratable acidity, salt concentration, biogenic amine contents namely histamine, tyramine, putrescine, cadaverine, 2-phenylethylamine, spermidine, and tryptamine.

Other than that, there was also no difference in organic acid contents including for lactic, acetic, succinic, formic, malic, oxalic, citric, L-pyroglutamic, and fumaric acids between naturally and acid-assisted fermented *ikan pekasam* samples. However, there were significant differences ($p \leq 0.05$) in amino acid contents namely leucine,

isoleucine, valine, phenylamine, tyrosine, methionine and cysteine between naturally and acid-assisted fermented *ikan pekasam* samples. Garcinic and tartaric acids were detected in all samples fermented with added *G. arthroviridis* slices and tamarind pulp, respectively. In general, biogenic amine, UCA, and organic acid contents varied greatly in both natural and acid-assisted fermented *ikan pekasam* samples. Sensory evaluation of the fifteen samples based on 9-hedonic scale indicated that there was no difference ($p > 0.05$) between natural and acid-assisted fermented *ikan pekasam*.

Based on the sensory acceptability results of commercial *ikan pekasam* samples, *ikan pekasam* was then prepared from black pomfret (*Parastromateus niger*) using two separate processes used in natural and acid-assisted fermentation. In the first part, the fish were naturally fermented after they were mixed with 20% (w/w) salt for 3 days, washed after which equal proportion (w/w) of ground roasted rice and 10% (v/w) water were added to each batch and then mixed. For acid-assisted fermentation in the second part, black pomfret (*P. niger*) was mixed 100% salt (w/w). After salting for 1 week, 50% (w/w) of ground roasted rice, 3% (w/w) tamarind pulp, and 150% (v/w) water were added to each batch and also mixed. After mixing, all of batches were allowed to ferment for up to five weeks at ambient temperature for further analysis. According to the results of analysis, there were significant differences ($p \leq 0.05$) in physicochemical properties between different fermentation periods in both fermentation processes (natural and acid-assisted). For examples, pH value was significantly lower ($p \leq 0.05$) in five weeks fermented black pomfret compared to two and zero weeks fermented black pomfret. Other than that, biogenic amine, *trans*- and *cis*-UCA, and organic acid contents were significantly higher ($p \leq 0.05$) in five weeks fermented black pomfret compared to two and zero weeks fermented black pomfret.

Furthermore, there were only slight differences in physicochemical and sensory properties between *ikan pekasam* made from black pomfret, a marine fish, and *ikan pekasam* made from freshwater fish (black tilapia and *lampam jawa*). For example, there were significant differences ($p \leq 0.05$) in total biogenic amine, total UCA (*trans*- plus *cis*-UCA), total organic acid including lactic, acetic, malic, and formic acids contents. However, there were many similarities between *ikan pekasam* from marine and freshwater fish including pH values, titratable acidity, salt content, and especially biogenic amine concentrations, namely histamine, tyramine, putrescine, cadaverine, 2-phenylethylamine, spermidine, and tryptamine.

Based on the sensory evaluation using quantitative descriptive analysis (QDA), the intensity of attributes in two and five weeks naturally fermented black pomfret such as sourness odor, cohesiveness of fish flesh, sourness, saltiness, fishy, and fermented flavors were significantly higher ($p \leq 0.05$) than two and five weeks acid-assisted fermented black pomfret, respectively. Furthermore, the panelists could detect significant ($p \leq 0.05$) differences in five weeks naturally and acid-assisted fermented black pomfret samples, whereas the intensity of color, roughness of fish skin, sourness

odor, sourness flavor, saltiness flavor, bitterness flavor, fishy flavor, fermented flavor, crispiness of fish skin, and oiliness texture increased as the fermentation time was increased.

Also, there was no significant difference ($p > 0.05$) in overall acceptability scores between naturally and acid-assisted fermented *ikan pekasam* from freshwater fish (black tilapia and *lampam jawa*) and marine fish (black pomfret). It could be concluded that Malaysian traditional fermented freshwater fish (black tilapia and *lampam jawa*) and marine fish (black pomfret) can be consumed without any health risks. In general, there was no difference in most of the physicochemical and sensory properties between naturally and acid-assisted fermented fish even from different type of fish or fermentation process. However, there were significant differences ($p \leq 0.05$) in physicochemical properties between different fermentation periods in naturally and acid-assisted fermented black pomfret, respectively.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi sebahagian keperluan untuk Sarjana Sains

**PENCIRIAN IKAN PEKASAM TEMPATAN DAN PERKEMBANGAN PROSES
PENGHASILAN IKAN PEKASAM DARIPADA BAWAL HITAM
(*Parastromateus niger* BLOCH)**

Oleh

EZZAT BINTI MOHAMAD AZMAN

Julai 2014

Pengerusi : Professor Hasanah Mohd Ghazali, PhD
Fakulti : Sains dan Teknologi Makanan

Ikan pekasam adalah produk ikan pemeraman yang dihasilkan di Malaysia. Ia biasanya diperbuat daripada ikan air tawar, dan beras panggang yang dikisar adalah sumber utama karbohidrat untuk proses fermentasi. Dalam ujikaji ini, sifat-sifat deria dan fizikokimia seperti pH, keasidan tertitrat, kandungan garam, asid amino, biogenic amine, *trans*- dan *cis*-UCA, dan asid organik di dalam 15 sampel komersial telah dikaji. Kebiasaannya, sampel ikan pekasam dihasilkan daripada dua jenis ikan air tawar, iaitu lampam jawa (*P. gonionotus*) dan tilapia hitam (*O. mossambicus*), yang melalui proses fermentasi secara semulajadi atau asid-bantuan. Sampel fermentasi asid-bantuan dijalankan dengan memasukkan pulpa asam jawa (*T. indica*) atau hirisan kering *G. atroviridis* (asam keping) sebagai bahan dalam proses fermentasi. Terdapat perbezaan signifikan ($p \leq 0.05$) dalam nilai pH, jumlah UCA (jumlah *trans*- dan *cis*-UCA) dan kandungan *cis*-UCA di antara sampel ikan pekasam yang melalui proses fermentasi secara semulajadi atau asid-bantuan. Namun, terdapat banyak persamaan termasuk keasidan tertitrat, kepekatan garam, kandungan biogenic amine iaitu histamine, tyramine, putrescine, cadaverine, 2-phenylethylamine, spermidine, dan tryptamine.

Tiada perbezaan dalam kandungan asid organik termasuk asid laktik, asetik, succinic, formic, malic, oxalic, citric, L-pyroglutamic, dan fumaric di antara sampel ikan pekasam yang melalui proses fermentasi secara semulajadi atau asid-bantuan. Walaubagaimanapun, terdapat perbezaan signifikan ($p \leq 0.05$) di antara ikan pekasam

yang diperam secara semulajadi dan asid-bantuan dalam kandungan asid amino iaitu leucine, isoleucine, valine, phenylamine, tyrosine, methionine, dan cysteine. Asid garcinic dan tartarik dikesan di semua sampel yang masing-masing diperam dengan asam keping dan pulpa asam jawa. Umumnya, biogenic amine, UCA, dan kandungan asid organik amat berbeza dalam kedua-dua sampel ikan pekasam yang diperam secara semulajadi dan asid-bantuan. Penilaian deria daripada lima belas sampel berdasarkan 9-skala hedonik menunjukkan bahawa tiada perbezaan ($p > 0.05$) antara ikan pekasam diperam secara semula jadi dan asid-bantuan.

Berdasarkan kepada keputusan penilaian deria ke atas sampel ikan pekasam komersial, ikan pekasam telah disediakan daripada bawal hitam (*P. niger*) menggunakan dua proses berasingan iaitu fermentasi semulajadi dan asid-bantuan. Dalam bahagian pertama, ikan telah diperam secara semulajadi selepas dicampur dengan 20% (w/w) garam selama 3 hari, selepas itu dibasuh dan beras panggang yang dikisar dicampur dengan sama kadarnya (w/w) dan 10% (v/w) air telah ditambah kepada setiap kelompok dan kemudian digaul. Dalam fermentasi asid bantuan di bahagian kedua, bawal hitam (*P. niger*) dicampur dengan garam 100% (w/w). Selepas proses pemasinan selama seminggu, 50% (w/w) beras panggang yang dikisar, 3% (w/w) pulpa asam jawa, dan 150 % (v/w) air telah ditambah kepada setiap bekas dan seterusnya digaul. Selepas itu, semua sampel dibiarkan untuk diperam sehingga lima minggu pada suhu ambien untuk analisis selanjutnya. Menurut analisis, terdapat perbezaan yang signifikan ($p \leq 0.05$) dalam ciri fizikokimia antara tempoh penapaian dalam kedua-dua proses fermentasi (semula jadi dan asid-dibantu). Contohnya, nilai pH adalah lebih rendah ($p \leq 0.05$) dalam ikan pekasam bawal hitam yang diperam selama lima minggu berbanding bawal hitam yang diperam selama dua dan kosong minggu. Selain itu, kandungan biogenic amine, *trans* dan *cis*-UCA, dan asid organik adalah lebih tinggi ($p \leq 0.05$) dalam ikan pekasam bawal hitam yang diperam selama lima minggu berbanding bawal hitam yang diperam selama dua dan kosong minggu.

Tambahan pula, hanya terdapat sedikit perbezaan antara ikan pekasam yang diperbuat daripada ikan laut (bawal hitam) dan ikan pekasam yang diperbuat daripada ikan air tawar (tilapia hitam dan lampam jawa). Contohnya, terdapat perbezaan signifikan ($p \leq 0.05$) dalam jumlah biogenic amine, jumlah UCA (*trans*- dan *cis*-UCA), jumlah asid organik termasuk asid laktik, asetik, malik, dan formik. Walaubagaimanapun, terdapat banyak persamaan antara ikan pekasam dari laut dan ikan air tawar termasuk nilai pH, keasidan tertitrat, kandungan garam, dan biogenic amine (histamine, tyramine, putrescine, cadaverine, 2-phenylethylamine, spermidine, dan tryptamine).

Berdasarkan pada penilaian deria dengan menggunakan analisis deskriptif kuantitatif, keamanan sifat dalam bawal hitam yang masing-masing diperam selama dua dan lima minggu secara semulajadi seperti bau masam, kesepaduan daging ikan, rasa masam, masin, hanyir, dan rasa diperam adalah jauh lebih tinggi ($p \leq 0.05$) daripada bawal hitam yang masing-masing diperam selama dua dan lima minggu secara asid bantuan.

Tambahan pula, ahli-ahli panel dapat mengesan secara signifikan ($p \leq 0.05$) perbezaan dalam bawal hitam yang diperam selama lima minggu secara semulajadi dan asid bantuan, manakala keamatan warna, kekasaran kulit ikan, bau masam, rasa masam, masin, pahit, hanyir, rasa ditapai, kegarangan kulit ikan, dan tekstur kulit berminyak meningkat seiring dengan masa fermentasi.

Selain itu, tiada perbezaan signifikan ($p > 0.05$) dalam skor penerimaan keseluruhan antara sampel ikan pekasam komersial dan sampel ikan pekasam daripada bawal hitam. Kesimpulannya, ikan pekasam komersial dari sumber air tawar di Malaysia (tilapia hitam dan lampan jawa) dan ikan laut (bawal hitam) boleh dimakan tanpa sebarang risiko kesihatan. Secara umum, tiada perbezaan dalam kebanyakan sifat fizikokimia dan penilain deria antara ikan yang diperam secara semulajadi dan asid-bantuan walaupun menggunakan berlainan jenis ikan atau proses fermentasi. Namun, terdapat perbezaan yang signifikan ($p \leq 0.05$) dalam ciri fizikokimia antara tempoh penapaian dalam bawal hitam yang diperam secara semulajadi dan asid-bantuan.

ACKNOWLEDGEMENTS

I would like to express my deepest appreciation to Prof Dr. Hasanah Mohd Ghazali, the chairman of my Supervisory Committee for her kind assistance, advice, valuable discussions, supports and comments during my study. Thank you very much for being my supervisor, always having time for any help on any time, besides providing me with complete research equipment to complete my research lab works. I am also grateful to another my co-supervisor, Associate Prof. Dr. Roselina Karim for her training she gave me on sensory evaluation, advice and support during this research.

I would like to thank the staffs from sensory and biochemistry lab, Faculty Food Science and Technology, UPM. I would like also to thank Department of Fisheries Malaysia for helping me to find the small *ikan pekasam* producers from the whole country. I wish to thank the panelists, who willing to perform the sensory evaluation test on *ikan pekasam* samples, and not forgotten my lab mates at Enzyme Lab, Faculty of Food Science and Technology. Thanks a lot for your support and being always helpful throughout my study.

Last but not least, I gratefully acknowledge the Ministry of Education Malaysia for providing financial support during completing my Master study.

I certify that a Thesis Examination Committee has met on 23 July 2014 to conduct the final examination of Ezzat Binti Mohamad Azman on her thesis entitled "Characterisation of Local *Ikan Pemasam* and Development of Process for Production of *Ikan Pemasam* from Black Pomfret (*Parastromateus niger* Bloch)" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

Badlishah Sham bin Baharin

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

Yaya Rukayadi, PhD

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

Son Radu, PhD

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

Norrakiah binti Abdullah Sani, PhD

Senior Lecturer
Universiti Kebangsaan Malaysia
Malaysia
(External Examiner)



NORITAH OMAR, PhD
Associate Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 18 August 2014

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the supervisory committee were as follows:

Hasanah Mohd Ghazali, PhD

Professor

Faculty of Food Science and Technology

Universiti Putra Malaysia

(Chairman)

Roselina Karim, PhD

Associate Professor

Faculty of Food Science and Technology

Universiti Putra Malaysia

(Member)

BUJANG BIN KIM KUAT, PhD

Professor and Dean

School of Graduate Studies

Universiti Putra Malaysia

Date:

Declaration by graduate student

I hereby confirm that:

- This thesis is my original work;
- Quotations, illustrations and citations have been duly referenced;
- This thesis has not been submitted previously or concurrently for any other degree at any institutions;
- Intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- Written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and Innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- There is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2013 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software.

Signature: _____

Date: _____

Name and Matric No.: _____

Declaration by Members of Supervisory Committee

This is to confirm that:

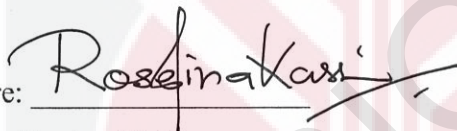
- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) are adhered to.

Signature: _____



Hasanah Mohd Ghazali, PhD
Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Chairman)

Signature: _____



Roselina Karim, PhD
Associate Professor
Faculty of Food Science and Technology
Universiti Putra Malaysia
(Member)

TABLE OF CONTENTS

	Page
DEDICATION	
ABSTRACT	i
ABSTRAK	iv
ACKNOWLEDGEMENTS	vii
APPROVAL	viii
DECLARATION	x
LIST OF TABLES	xv
LIST OF FIGURES	xviii
LIST OF ABBREVIATIONS	xxi
CHAPTER	
1 INTRODUCTION	1
2 LITERATURE REVIEW	4
Fermentation	4
Types of Fermentation	5
Categories of Fermentation	6
Overall Types of Fermented Fish	8
<i>Plaa-som</i>	8
<i>Som fug</i>	9
<i>Feseekh</i>	9
<i>Jeotkal</i> and <i>Myeolchi-jeot</i>	10
<i>Bakasang</i>	11
<i>Ikan pekasam</i>	12
Salt	13
Starch	15
Enzymes	16
Lactic acid Fermentation	17
Amino Acid Composition	18
Biogenic Amine Composition	19
<i>Trans</i> -and <i>Cis</i> -Urocanic Acid (UCA)	21
Organic Acid Composition	22
Black Pomfret (<i>Parastromateus niger</i>)	24
Sensory Analysis	26
Hedonic Scaling Test	26
Quantitative Descriptive Analysis (QDA)	26

3	PHYSICOCHEMICAL ANALYSIS AND SENSORY EVALUATION OF LOCALLY PRODUCED <i>IKAN PEKASAM</i>	28
	Introduction	28
	Materials and Methods	30
	Materials	30
	Sample Collection	30
	Methods	31
	A. Sampling procedure	31
	B. Physico-chemical characterization	33
	Determination of pH and Titratable Acidity	33
	Determination of Salt Content	33
	Determination of Amino Acid Composition and Content	34
	Determination of Biogenic Amine Composition and Content	36
	Determination of <i>Trans</i> - and <i>Cis</i> -Urocanic Acid (UCA) Composition and Content	37
	Determination of Organic Acid Composition and Content	38
	C. Sensory Analysis	39
	D. Statistical Analysis	41
	Results and Discussion	42
	pH, Titratable Acidity and Salt Content	42
	Amino Acid Composition and Content	44
	Biogenic Amine Composition and Content	49
	<i>Trans</i> - and <i>Cis</i> -Urocanic Acid (UCA) Composition and Content	56
	Organic Acid Composition and Content	62
	Sensory properties	73
	Conclusion	78
4	PRODUCTION OF <i>IKAN PEKASAM</i> FROM BLACK POMFRET (<i>Parastromateus niger</i>) USING NATURAL AND ACID-ASSISTED FERMENTATION PROCESSES	79
	Introduction	79
	Materials and Methods	80
	Materials	80
	Methods	81
	Preparation of <i>ikan pekasam</i> from black pomfret	81
	Production of naturally fermented black pomfret	81
	Production of acid-assisted fermented black pomfret	83
	Physicochemical analyses	83
	Statistical Analysis	84
	Results and Discussion	85
	A. Naturally fermented black pomfret	85
	pH, Titratable Acidity and Salt Content	85

	Biogenic Amine Composition and Content	86
	<i>Trans</i> - and <i>cis</i> - UCA Composition and Content	90
	Organic Acid Composition and Content	93
	B. Acid-assisted fermented black pomfret	97
	pH and Titratable Acidity	97
	Biogenic Amine Composition and Content	98
	<i>Trans</i> - and <i>cis</i> -UCA Composition and Content	102
	Organic Acid Composition and Content	105
	Conclusion	109
5	SENSORY QUALITY OF IKAN PEKASAM MADE FROM BLACK POMFRET (<i>Parastromateus niger</i>)	110
	Introduction	110
	Materials and Methods	111
	A. Preparation of <i>ikan pekasam</i> made from black pomfret	111
	B. Preparation for sensory analysis	111
	C. Sensory Evaluation	111
	Pre-screening of panelists	111
	Selection of Panelists	112
	Training of Panelists for Quantitative Descriptive Analysis (QDA)	112
	Evaluation of <i>Ikan pekasam</i> from Black Pompret using QDA	114
	Sensory Evaluation using the Hedonic Scale	114
	D. Statistical Analysis	115
	Results and Discussion	116
	Quantitative descriptive analysis (QDA) of naturally and acid-assisted fermented black pomfret	116
	Hedonic scale of naturally and acid-assisted fermented black pomfret	121
	Conclusion	126
6	SUMMARY, GENERAL CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH	127
	REFERENCES/ BIBLIOGRAPHY	130
	APPENDICES	150
	BIODATA OF STUDENT	167
	LIST OF PUBLICATIONS	168