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UNIVERSITI PUTRA MALAYSIA

EFFECTS OF COOKING MEDIUM AND BATTER FORMULATION ON QUALITY ATTRIBUTES OF FRIED FISH FILLETS

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FSTM 2008 8

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By

YAZDAN MORADI

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

December 2008

DEDICTED TO MY BELOVED FAMILY

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

EFFECTS OF COOKING MEDIUM AND BATTER FORMULATION ON QUALITY ATTRIBUTES OF FRIED FISH FILLETS

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Chairman : Professor Jamilah Bakar, PhD

Faculty : Food Science and Technology

Fried breaded fish fillets are consumed for their unique flavor and textural characteristics which are contributed by the preparation and the breading process. However, the cooking process can cause detrimental changes to the highly valued lipid characteristics of the fish lipid. Therefore, this study was carried out with the objectives of evaluating the changes that could be brought upon by the presence of breading materials, preparation process (pre-frying and pre-drying) and the cooking methods on the desired quality attributes of the breaded fish fillets. The effects of resistant starches on the quality attributes of the breaded fillets were also evaluated. The breaded and non-breaded black pomfret (*Parastromateus niger*) fillets were

deep-fried in sunflower oil and palm olein and evaluated for the physico-chemical properties such as fat content, moisture loss, texture and color changes. The frying process significantly ($P<0.05$) changed the fat and moisture content in the fillets. The presence of breading materials decreased significantly ($P<0.05$) the moisture loss and the fat uptake. However, the lipid compositions were observed to change significantly. The n-3/n-6 ratios were decreased in all fried samples. The palm olein fried samples had significantly ($P<0.05$) higher n-3/n-6 ratio than the sunflower oil fried samples. Breaded fillets were also pre-fried prior to frozen storage to evaluate the effect of pre-frying on the lipid profile of the samples. The pre-frying treatments resulted in the decrease of the saturated fatty acids concentration and an increase of the monounsaturated fatty acids for all samples. The polyunsaturated fatty acids content was found to increase in the sunflower oil fried samples and decreased in the palm olein fried ones. The effects of three final cooking methods on the quality attributes of breaded fillets were also determined. Among the three methods, oven cooking had the least changes in the parameters evaluated. The concentration of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) in the oven cooked samples was about two times higher than the samples cooked by other methods. Oven cooking methods also showed lower thermal oxidation and higher n-3/n-6 ratio than the other two cooking methods. The highest and lowest values of hardness in the final product were observed for those fried and microwaved, respectively. Pre-drying before frying of breaded fillets affected the moisture content, the fat content and the hardness of the final product significantly ($P<0.05$). A positive correlation ($r = 0.90$) between the pre-drying time and moisture content, and between pre-drying time and

hardness (r = 0.96), and a negative correlation between the pre-drying time and the fat uptake (r = -0.78) were found. The incorporation of the resistant starches in the batter formulation affected all trends of moisture and fat migration in and out of the breading materials. The moisture content increased while the fat content decreased significantly ($P<0.05$) in all breaded samples containing resistant starches as compared to the control. A significant ($P<0.05$) increase in hardness and crispiness of the samples containing resistant starches were also observed.

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

Kesan medium penggorengan, teknik pra-pengeringan dan formulasi adunan pada kualiti isi ikan bersalut

Oleh

YAZDAN MORADI

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Isi ikan bersalut yang telah digoreng, dimakan kerana keunikan pada sifat citarasa teksturnya yang dipengaruhi oleh kaedah pemprosesan dan penyalutannya. Namun begitu, proses memasak boleh menyebabkan perubahan yang tidak diingini pada sifat lipid ikan. Oleh itu, objektif kajian ini adalah untuk menilai perubahan yang disebabkan oleh bahan penyalut, cara pemprosessan (pra-penggorengan dan pra-pengeringan) dan kaedah memasak ke atas kualiti isi ikan bersalut. Kesan kanji berentang (resistant starch) pada kualiti isi ikan bersalut juga dinilai. Isi ikan bawal hitam (*Parastromateus niger*) bersalut dan tidak bersalut digoreng dengan minyak bunga matahari dan minyak olein kelapa sawit dinilai untuk sifat fiziko-kimia seperti

kandungan lemak, kehilangan air, tekstur dan perubahan warna. Proses penggorengan menunjukkan perubahan ketara ($P<0.05$) pada kandungan lemak dan kelembapan isi ikan. Dengan adanya bahan penyalutan, penyerapan lemak dan kehilangan air ($P<0.05$) adalah ketara. Namun begitu, komposisi lemak telahpun berubah dengan ketara. Nisbah n-3/n-6 telah menurun dalam kesemua sampel yang digoreng. Sampel yang digoreng dalam minyak kelapa sawit mempunyai nisbah n-3/n-6 yang lebih tinggi daripada sampel yang digoreng di dalam minyak bunga matahari. Isi ikan bersalut yang di pra-goreng sebelum disejukbekukan dinilai untuk kesan pra-penggorengan keatas profil lemak sampel. Rawatan pra-penggorengan mengurangkan asid lemak tepu dan meningkatan asid lemak tak-tepu bagi semua sampel. Asid lemak tak-tepu didapati meningkat dalam sampel yang digoreng dengan minyak bunga matahari dan berkurangan dalam sampel yang digoreng dengan minyak isirong kelapa sawit. Kesan tiga kaedah memasak pada kualiti isi ikan bersalut juga dikaji. Diantara ketiga-tiga kaedah tersebut, memasak dengan ketuhar menunjukkan perubahan yang paling kecil pada parameter yang dikaji. Kepekatan asid *eicosapentaenoic* (EPA) dan asid *docosahexaenoic* (DHA) dalam sampel yang dimasak dengan ketuhar adalah dua kali ganda lebih tinggi berbanding dengan sampel yang dimasak dengan kaedah lain. Kaedah memasak dengan ketuhar menunjukkan pengoksidaan therma dan nisbah n-3/n-6 yang tinggi berbanding dengan dua kaedah memasak yang lain. Nilai kekerasan adalah tertinggi pada sampel yang digoreng dan terendah pada sampel yang dimasak dengan ketuhar gelombang mikro. Kaedah pra-pengeringan sebelum isi ikan bersalut digoreng dengan ketara mempengaruhi kandungan lemak dan kekerasan produk terakhir dengan ketara ($P<0.05$). Korelasi positif ($r = 0.90$) diantara masa pra-

pengeringan dan kandungan air, dan diantara masa pra-pengeringan dengan kekerasan ($r = 0.96$) manakala korelasi negatif diantara masa pra-pengeringan dan penyerapan lemak ($r = - 0.78$) telah deperolehi. Penggunaan kanji rentangan di dalam formulasi *batter* memberi kesan ke atas tren perpindahan air dan lemak di dalam dan diluar bahan salutan. Kandungan air meningkat manakala kandungan lemak berkurangan ($P<0.05$) dengan ketara pada sampel bersalut yang mengandungi kanji rentangan berbanding dengan kawalan. Peningkatan yang ketara pada kekerasan dan kerangupan bagi sampel yang mengandungi kanji rentangan juga diperhatikan.

ACKNOWLEDGEMENTS

All praise and thanks for Almighty Allah who has given me all the best during all stages of my study. I would like to start by expressing my deepest gratitude, appreciation and thanks to Professor Dr. Jamilah Bakar for her kind supervision, assistance and encouragement during the preparation of this thesis. I also thank members of my supervisory committee, Professor Dr. Yaakob Che Man and Associate Professor Dr. Sharifah Kharidah for their advice, constructive comments and support.

I would like also to acknowledge the financial support provided by the Ministry of Jahad Keshavarzi and Ministry of Science, Research and Technology of Islamic Republic of Iran for this study.

My sincere gratitude also goes to the technicians; Mr. Mohammd Soib in the engineering lab, Mr. Razali Othman in the processing lab, Mr. Azman and Mrs. Lina in the biochemistry lab, Mr. Ho from Institute Bioscience and En. Dzulkifly from Halal Products Research Institute.

I certify that an Examination Committee met on 05 / 12 / 2008 to conduct the final examination of Yazdan Moradi on his PhD degree of Food Technology thesis entitled "Effects of cooking medium and batter formulation on quality of fried fish fillets" in accordance with Universiti Pertanian Malaysia (higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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This thesis was submitted to the Senate of 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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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 UPM or at any other institutions.

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YAZDAN MORADI

Date: 22 / 12 / 2008

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES