



**UNIVERSITI PUTRA MALAYSIA**

**DIETARY EXPOSURE AMONG ADULTS IN SELANGOR, MALAYSIA,  
TO HETEROCYCLIC AMINES AND POLYCYCLIC AROMATIC  
HYDROCARBONS IN COOKED MEAT AND FISH**

**MD. JAHURUL HAQUE AKANDA**

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HETEROCYCLIC AMINES AND POLYCYCLIC AROMATIC  
HYDROCARBONS IN COOKED MEAT AND FISH**

**By**

**MD. JAHURUL HAQUE AKANDA**

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

**September 2010**

## DEDICATION

**To my father Md. Kalim Uddin Akanda, mother Mrs. Jhora Begum,  
son Md. Mausooof Zobaer and my wife Maksuda Khatun**



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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

**DIETARY EXPOSURE AMONG ADULTS IN SELANGOR, MALAYSIA, TO  
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HYDROCARBONS IN COOKED MEAT AND FISH**

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**September 2010**

**Chair: Professor Jinap Selamat, PhD**

**Faculty: Faculty of Food Science and Technology**

Heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs) are possible human carcinogens and potent mutagens which increase the incidence of colon, mammary, prostate, breast and other cancers in rodents. Food containing meat and fish are the most important source of exposure to HCAs and PAHs in the diet and heat-treated foods, especially those which are fried, broiled and grilled. The intake of HCAs and PAHs are influenced by the amount and type of meat and fish ingested, frequency of consumption, cooking methods, cooking temperature and duration of cooking. The aim of the present study was to determine the level of HCAs and PAHs in the most consumed foods in Selangor, Malaysia in order to estimate their exposure to these toxic compounds. The dietary intake of HCAs and PAHs in foods consumed by people in Selangor, Malaysia was determined. Levels of six HCAs, namely: 2-amino-3-methylimidazo[4,5-f]quinoline (IQ), 2-amino-3,4-dimethylimidazo[4,5-f] quinoline (MeIQ), 2-amino-3,8-dimethylimidazo[4,5-f]quinoxaline (MeIQx), 2-amino-3,4,8-trimethylimidazo[4,5-f]quinoxaline (4, 8-

DiMeIQx), 2-amino-1-methyl-6-phenylimidazo[4,5-b]pyridine (PhIP) and 2-amino-3,7,8-trimethylimidazo[4,5-f] quinoxaline (7,8-DiMeIQx) and three PAHs, fluoranthene, benzo[b]fluoranthene and benzo[a]pyrene were measured. Forty-two samples of meat and fish were included in the study. High-performance liquid chromatography with photodiode array detector and fluorescence detector was used to analyze HCAs and PAHs, respectively. Dietary food consumption data (g/day), including meat type and cooking method were obtained using food frequency questionnaires, which were completed by 600 randomly selected subjects aged above 18 years.

Results of the study showed that the level of total HCAs in food samples studied ranged from 0 to 38.7 ng/g whereas the level of total PAHs was, 0 to 66.28 ng/g. Among the analyzed HCAs and PAHs, PhIP (30.6 ng/g) and fluoranthene (50.96 ng/g) showed the highest level, respectively. The highest level of total HCAs was found in grilled chicken satay (38.7 ng/g) and for PAHs it was in grilled beef satay (66.28 ng/g). The most abundant HCAs such as PhIP and MeIQx, and for PAHs such as fluoranthene were detected in the food products studied. The 4,8-DiMeIQx, 7,8-DiMeIQx (HCAs) for HCAs and benzo[a]pyrene for PAHs were found in 12 and 22% of the meat and fish dishes. The average daily intake level of HCAs was 553.7 ng/capita/day and for PAHs of 297.58 ng/capita/day. The intake of PhIP was the highest, followed by MeIQx and MeIQ, whereas intake of fluoranthene was the highest, followed by benzo[b]fluoranthene and benzo[a]pyrene. The results reveal that grilled and fried meat and fish products were the major contributors to the exposure of HCAs and PAHs.

**Pendedahan melalui pemakanan terhadap antara dewasa di Selangor, Malaysia, heterosiklik amina dan Polisiklik aromatik hidrokarbon dalam daging dan ikan yang dimasak**

Oleh

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Heterosiklik amina (HCAs) dan polisiklik aromatik hidrokarbon (PAHs) adalah pencemar yang bersifat karsinogen kepada manusia dan merupakan mutagen kuat yang meningkatkan kadar kanser usus, prostat, payu dara dan kanser lain dalam tikus. Makanan yang mengandungi daging dan ikan ialah sumber paling penting pendedahan kepada HCAs dan PAHs dalam diet dan makanan yang dipanaskan pada suhu tinggi, terutamanya makanan yang digoreng, dipanggang dan dibakar. Pengambilan HCAs dan PAHs dalam makanan adalah dipengaruhi oleh jumlah dan jenis daging dan ikan yang dimakan, kekerapan pengambilan, kaedah memasak, suhu memasak dan tempoh memasak. Matlamat kajian ini ialah untuk menentukan tahap HCAs dan PAHs dalam makanan yang paling banyak diambil oleh pengguna di Selangor, Malaysia untuk menganggar pendedahan mereka terhadap sebatian toksik ini. Pengambilan diet harian bagi dua jenis karsinogen, HCAs dan PAHs dalam makanan dimakan oleh rakyat di Selangor, Malaysia telah ditentukan. Tahap bagi enam HCAs, iaitu: 2-amino-3-methylimidazo[4,5-f]kuinolina (Iq), 2-amino-3-4-dimethylimidazo[4,5-f]kuinolina (MeIQ), 2-amino-3-8-dimethylimidazo[4,5-f]quinoxaline (MeIQx), 2-amino-3,4,8-trimethylimidazo[4,5-f]quinoxaline (4, 8-DiMeIQx), 2-amino-1-methyl-6-phenylimidazo[4,5-b]piridina (PhIP) dan 2-amino-

3,7,8-trimethylimidazo[4,5f]quinoxaline (7,8-DiMeIQx) dan tiga PAHs, fluoranthene, benzo[b]fluoranthene dan benzo[a]pyrene telah diukur. Empat puluh dua sampel masaban daging dan ikan telah dimalisis dalam kajian ini. Kromatografi cecair berprestasi tinggi dengan pengesan fotodiod arai dan pengesan pendarfluor, masing-masing telah digunakan untuk menganalisa HCAs dan PAHs. Data pengambilan diet makanan (g/hari), termasuk jenis daging dan kaedah memasak telah diperolehi menggunakan soal selidik kekerapan pengambilan makanan, yang telah dilengkapkan oleh 600 responden berusia 18 tahun ke atas yang dipilih secara rawak.

Hasil kajian telah didapati dan tahap jumlah HCAs dalam sampel makanan yang dikaji adalah dalam lingkungan daripada 0 hingga 38.7 ng/g manakala tahap jumlah PAHs adalah dalam lingkungan 0 hingga 66.28 ng/g. Antara HCAs dan PAHs yang dianalisa, PhIP (30.6 ng/g) dan fluoranthene (50.96 ng/g) masing-masing menunjukkan tahap yang tertinggi. Tahap tertinggi jumlah HCAs telah didapati dalam sate ayam panggang (38.7 ng/g) dan untuk PAHs ia berada dalam sate daging lembu panggang (66.28 ng/g). Sebatian HCAs seperti PhIP dan MeIQx, dan PAHs seperti fluoranthene adalah paling banyak dikesan dalam produk makanan yang dikaji. 4,8-DiMeIQx dan 7,8-DiMeIQx (HCAs) serta benzo[a]pyrene (PAHs) didapati dalam beberapa hidangan daging dan ikan. Tahap purata pengambilan harian bagi HCAs ialah 553.7 ng/kapita/hari dan bagi PAHs adalah 297.58 ng/kapita/hari. Pengambilan PhIP adalah yang tertinggi, diikuti oleh MeIQx dan MeIQ, manakala pengambilan fluoranthene adalah yang tertinggi, diikuti oleh benzo[b]fluoranthene dan benzo[a]pyrene. Keputusan membuktikan bahawa produk daging dan ikan yang dipanggang dan digoreng adalah penyumbang utama bagi pendedahan HCAs dan PAHs.

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I certify that a Thesis Examination committee has met on **29 / 09 / 2010** to conduct the final examination of Md. Jahurul Haque Akanda on his thesis entitled **Dietary exposure among adults in Selangor, Malaysia, to heterocyclic amines and polycyclic aromatic hydrocarbons in cooked meat and fish** 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.

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### **DECLARATION**

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledge. 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 institution.

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**MD. JAHURUL HAQUE AKANDA**

Date: 29 September 2011

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