For information on
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LegCo Panel on Food Safety and Environmental Hygiene

Study on Acrylamide in Food

Purpose

This paper presents the findings of the study conducted by the Food and Environmental Hygiene Department (FEHD) on acrylamide in Asian indigenous foods that form part of the local diet.

Background

2. Acrylamide is a chemical that has long been used to make polyacrylamide materials which have a variety of industrial uses e.g. treatment of drinking water and waste water, manufacturing of plastics, paper and cosmetics, etc. The main health concerns regarding acrylamide are on its potential to cause cancer in humans and its toxic effects on the nervous system. While acrylamide is known to cause cancer in laboratory animals, the International Agency for Research on Cancer (IARC)[1] stated that the evidence available was not adequate to establish the carcinogenicity of acrylamide to humans. Concerning its adverse effects on the nervous system, acute toxicity is rare but acrylamide has been found to cause nerve damage in people who have long term exposure to high doses at work. The World Health Organization (WHO) has established a "No Observed Adverse Effect Level (NOAEL)"[2] of 0.5mg/kg (or 500 µg/kg) body weight per day for acrylamide with respect to its effects on the nervous system.

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[1] IARC, which is a part of the World Health Organization, is responsible for coordinating and conducting research on the causes of human cancer as well as developing scientific strategies for cancer control.

[2] NOAEL is the average maximum daily dose which does not produce detectable adverse effects over a lifetime exposure.

3. Although humans may have been exposed to acrylamide in foods for many years, the discovery of acrylamide in food was first known when the Swedish National Food Administration (NFA) announced its research findings in April 2002 that acrylamide was detected in a wide range of common foods, in particular starch-containing foods that were cooked at high temperature such as potato chips, cookies, toasts, etc. NFA's discovery has aroused worldwide research interest. Subsequent studies conducted by other overseas authorities also revealed similar findings. The highest levels of more than 3000µg/kg of food were detected in potato chips. However, scientific knowledge on how acrylamide is formed during the cooking process and its effects on people's health through consumption of food is still limited. In light of this, an expert consultation meeting was convened jointly by the Food and Agriculture Organization of the United Nations (FAO) and the WHO in June 2002 to review the findings of new and existing studies. Based on the available data, it was estimated that the dietary intake of acrylamide in the western diet was of the order 0.3 to 0.8 µg/kg body weight per day. The meeting concluded that the present information on acrylamide in food were not sufficient to warrant changes in the basic dietary advice by WHO of a balanced diet. The public was advised to eat more fruits and vegetables, moderate consumption of fried and fatty food, and avoid eating fried food which was cooked excessively. All food, especially meat and meat products, should however be thoroughly cooked to destroy foodborne pathogens. The meeting also recommended that further research and studies on the effects of acrylamide in human body, the situation in non-European and non-North American diets and the process leading to its formation during the cooking process were necessary.

4. Following the announcement of the findings by NFA, we have posted a "Risk-in-brief" on the website of FEHD and published an article in the Department's quarterly publication "Food Safety Bulletin" to convey appropriate advice to the trade and the public. In response to WHO's call for further research and noting that the currently available data released by overseas authorities were mainly on Western foods while research data on Asian foods was relatively scarce, we embarked on a study to assess the levels of acrylamide in local foods e.g. fried rice, fried noodles, fried dim sum, yau hei, etc. The study was supported by our

newly established Food Research Laboratory which has equipped us with the capability to develop testing protocols for conducting studies on specific local foods. It provided us with a good opportunity to contribute to international research efforts in developing a more thorough understanding of acrylamide in food as advocated by WHO.

Scope and Method of the Study

5. Currently available research findings reveal that raw foods and foods prepared by boiling do not contain appreciable levels of acrylamide. It is formed when foods, particularly those rich in carbohydrate, are cooked at above 120°C. However, the exact mechanism involved in acrylamide formation during the cooking process is still not clear and researches are underway in many parts of the world to facilitate analysis of the issue. In our study, we aim to

(a) assess the levels of acrylamide in local foods;
(b) estimate the local population's dietary exposure to acrylamide; and
(c) examine the effects of the variation of cooking temperatures and cooking time on the formation of acrylamide in foods.

6. Our study consisted of two parts. The first part involved the testing of acrylamide in a wide range of starch-containing Asian style foods available in the local market including Chinese, Japanese, Indian, Indonesian, Malaysian, Thai and Vietnamese style ones which were subject to high temperature cooking process like grilling, roasting, baking, barbecuing, frying, etc. Examples of typical food items studied were fried rice, fried noodles, fried dim sum, yau-hei, deep fried taro dumpling, spring roll, grilled sausage, deep-fried fish ball, instant noodles, snacks, etc. Some European style food items such as potato crisps were also tested. A total of 450 food samples were collected from the local market and sent to the FRL for analysis of acrylamide using Liquid Chromatograph-Tandem Mass Spectrometer (LC-MS/MS) as the test method, and 167 analyses were conducted. The detection limit was 3μg/kg of food. The results obtained were compared with international

findings on acrylamide levels in European style foods. Based on the testing results of the present study together with the data obtained from the food consumption survey conducted jointly by the Chinese University of Hong Kong and the University of Hong Kong in 1995 and the food consumption survey conducted by FEHD on secondary school students in 2000, the dietary exposures of the general public and the secondary school students to acrylamide were estimated respectively. The dietary exposure data thus computed are then compared with international data.

7. The second part of the study focused on the effects of variation of cooking temperatures and cooking time on the formation of acrylamide in foods. Chinese style fried fritter was chosen as the subject food item for this part of the study. Support was provided by a local restaurant in preparing the fried fritters. A total of 33 samples were taken and sent to the FRL for analysis of acrylamide using the same LC-MS/MS test method. These samples of fried fritters were prepared under different combinations of frying temperature (170°C, 190°C and 210°C) and frying time (ranging from 3 to 18 minutes at each temperature setting). The degrees of browning and the texture of the finished products were also recorded as parameters to assess its quality. The optimal frying temperature and frying time that would give a lower level of acrylamide yet with an acceptable quality to the consumers was identified. The critical points to minimize the formation of acrylamide in fried fritters were explored.

Results

8. Results of analyses showed that the majority of food products tested including the Asian style ones had a low level of acrylamide. The levels of acrylamide detected in European style foods ranged from <3 to 1700 µg/kg of food, and were compatible with the findings of the overseas studies in which western foods contained acrylamide levels ranging from below limit of detection to 3500 µg/kg. On the other hand, local Asian style food items in general were found to have lower levels of acrylamide than the European ones like potato crisps and potato chips. For example, local staple food such as rice and noodles that had been subjected to frying, deep-frying and baking had a median level of less

than 3µg/kg, while bread such as sandwich bread, pineapple bun, deep-fried bun, toast had a median level of less than 10µg/kg. The instant noodle samples were found to have less than 3µg/kg. Higher levels of acrylamide were found in some food products, such as Chinese style deep-fried taro dumpling (190µg/kg), fried fritter (130µg/kg), spring roll (60µg/kg), "guo-ba" (67µg/kg) and Japanese "teppan-yaki soba" (84µg/kg). Local popular snack food items such as grilled sausage, deep-fried fish ball and deep fried octopus had levels of less than 3µg/kg. One sample of Indonesian style grilled fish slice had a higher level of 93µg/kg.

9. From the specific study on the effects of variation of frying temperature and frying time for fried fritters, it was found that the level of acrylamide increased with frying time, and if the frying time was held constant, the level would be higher if higher frying temperature was used. Fried fritter cooked at lower temperature and longer frying time could produce products with lower levels of acrylamide yet of the same acceptable degree of quality when compared with those products that are produced by higher temperature and shorter time for frying. For example, the acrylamide level in a fried fritter sample reached 280µg/kg after being fried at 210°C for 5 minutes. The same texture and same degree of brownness were obtained when the product was prepared at a frying temperature and frying time of 170°C and 12 minutes respectively, yet with a lower level of acrylamide of 150µg/kg. It showed that the critical points in minimizing the formation of acrylamide in foods were the control of proper cooking temperatures and cooking times.

10. The study revealed that the dietary exposure of an average citizen in Hong Kong to acrylamide is about 0.3 µg/kg body weight per day while that for an average secondary school student is about 0.4 µg/kg. Both of them fell within the lower end of the range of dietary intake of acrylamide in the western diet (i.e. 0.3 to 0.8 µg/kg body weight per day) as estimated by the WHO at the expert consultation meeting in June 2002. This finding reaffirmed WHO's earlier conclusion that its basic dietary advice on a balanced and healthy diet needed not to be altered.

The Next Steps

11. Research efforts are being made by international researchers and food authorities to gain a better understanding on the presence of acrylamide in food. According to the WHO, information available on acrylamide so far reinforces the general advice on healthy eating. The public is advised to maintain a balanced diet, eat more fruits and vegetables, moderate consumption of fried and fatty food, and avoid eating fried food which is cooked excessively. All food, especially meat and meat products, should however be thoroughly cooked to destroy foodborne pathogens.

12. Acrylamide in food has been put on the priority list for evaluation by the Joint FAO/WHO Expert Committee on Food Additives (JECFA) and JECFA will convene a meeting next year to evaluate the safety of acrylamide in foods based on international research findings. We would forward the data obtained in this study to WHO for reference of the situation concerning Asian style indigenous foods. We would also submit articles to international scientific journals to publish the findings of the study. Full report of the study will be uploaded onto the website of FEHD (http://www.fehd.gov.hk) and will be available at the Communication Resource Unit, the Health Education Exhibition and Resources Centre of FEHD as well as major public libraries.

Food and Environmental Hygiene Department
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