Heterocyclic Amines in Cooked Meats

Research has shown that cooking certain meats at high temperatures creates chemicals that are not present in uncooked meats. A few of these chemicals may increase cancer risk. For example, heterocyclic amines (HCAs) are the carcinogenic chemicals formed from the cooking of muscle meats such as beef, pork, fowl, and fish. HCAs form when amino acids (the building blocks of proteins) and creatine (a chemical found in muscles) react at high cooking temperatures. Researchers have identified 17 different HCAs resulting from the cooking of muscle meats that may pose human cancer risk.

Research conducted by the National Cancer Institute (NCI) as well as by Japanese and European scientists indicates that heterocyclic amines are created within muscle meats during most types of high temperature cooking.

Recent studies have further evaluated the relationship associated with methods of cooking meat and the development of specific types of cancer. One study conducted by researchers from NCI's Division of Cancer Epidemiology and Genetics found a link between individuals with stomach cancer and the consumption of cooked meats. The researchers assessed the diets and cooking habits of 176 people diagnosed with stomach cancer and 503 people without cancer. The researchers found that those who ate their beef medium-well or well-done had more than three times the risk of stomach cancer than those who ate their beef rare or medium-rare. They also found that people who ate beef four or more times a week had more

than twice the risk of stomach cancer than those consuming beef less frequently. Additional studies have shown that an increased risk of developing colorectal, pancreatic, and breast cancer is associated with high intakes of well-done, fried, or barbequed meats.

Four factors influence HCA formation: type of food, cooking method, temperature, and time. HCAs are found in cooked muscle meats; other sources of protein (milk, eggs, tofu, and organ meats such as liver) have very little or no HCA content naturally or when cooked. Temperature is the most important factor in the formation of HCAs. Frying, broiling, and barbecuing produce the largest amounts of HCAs because the meats are cooked at very high temperatures. One study conducted by researchers showed a threefold increase in the content of HCAs when the cooking temperature was increased from 200° to 250°C (392° to 482°F). Oven roasting and baking are done at lower temperatures, so lower levels of HCAs are likely to form, however, gravy made from meat drippings does contain substantial amounts of HCAs. Stewing, boiling, or poaching are done at or below 100°C (212°F); cooking at this low temperature creates negligible amounts of the chemicals. Foods cooked a long time ("well-done" instead of "medium") by other methods will also form slightly more of the chemicals.

Meats that are partially cooked in the microwave oven before cooking by other methods also have lower levels of HCAs. Studies have shown that microwaving meat prior to cooking helps to decrease mutagens by removing the precursors. Meats that were microwaved for 2 minutes prior to cooking had a 90-percent decrease in HCA content. In addition, if the liquid that forms during microwaving is poured off before further cooking, the final quantity of HCAs is reduced.

One study has evaluated the content of HCAs in fast food restaurants. After evaluating five kinds of meat products from various fast food restaurant chains, the study concluded that

there were low levels of HCAs found in fast food meat products due to factors such as cooking temperature and time. The study suggested that greater exposure to HCAs stems from home cooking and cooking in non-fast-food restaurants where food may be cooked to order and where a larger amount of meat is consumed.

Studies are being conducted to assess the amount of HCAs in the average American diet, but at present the maximum daily intake of HCAs in food has not been established. At the moment, no Federal agency monitors the HCA content of cooked meats (how much a person could be eating), there is no good measure of how much HCAs would have to be eaten to increase cancer risk, and there are no guidelines concerning consumption of foods with HCAs. Further research is needed before such recommendations can be made.

However, concerned individuals can reduce their exposure to HCAs by varying methods of cooking meats; microwaving meats more often, especially before frying, broiling, or barbecuing; and refraining from making gravy from meat drippings.

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Related Resources

Publications (available at http://www.cancer.gov/publications)

- *Cancer and the Environment: What You Need To Know, What You Can Do*
- *What You Need To Know About™ Cancer*

National Cancer Institute (NCI) Resources

Cancer Information Service (toll-free)

Telephone: 1–800–4–CANCER (1–800–422–6237)
TTY: 1–800–332–8615

Online

NCI's Web site: http://www.cancer.gov
LiveHelp, NCI's live online assistance:
https://cissecure.nci.nih.gov/livehelp/welcome.asp

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