

The grilling season is upon us! Outdoor grilling is as American as apple pie, but various research studies have identified health risks that can result from grilling foods over high heat. Getting your family and friends together for a barbeque is as American as apple pie, but backyard chefs should know some facts.....

A study from the University of Minnesota found that eating charred, well-done meat on a regular basis may increase your risk of pancreatic cancer by up to 60%.

When you grill poultry, fish or meats at high temperatures or directly over open flames, two cancer-causing compounds, called heterocyclic amines (HCAs) and polycyclic aromatic hydrocarbons (PAHs), can form. According to the [National Cancer Institute](#),

- Heterocyclic amines (HCAs) are created by the burning of amino acids and other substances in **meats and tested highest in grilled chicken breast**. It happens particularly at high temperatures and cooked well-done. HCAs turn up in grilled, smoked and barbecued meat as well as broiled and pan-fried meat.
- PAHs form in the flames and smoke that result from dripping fat and juices, then adhere to the surface of the meat.

Those compounds have been linked to increased risk of cancers, especially colon, stomach and breast cancer.

"Grilled chicken is the largest source of PhIP, a potent carcinogen," says Kristie Sullivan, M.P.H., lead author of the new study and a toxicologist with the Physicians Committee for Responsible Medicine. "We found this carcinogen in every single sample of grilled chicken taken from restaurants in every part of California." Wall Street 2009.

PhIP is one of a group of carcinogenic compounds called heterocyclic amines (HCAs), and it is a known mutagen that can cause DNA damage that can lead to cancer.

You don't have to give up your grill to stay healthy. You just need to choose sensible foods and use the right techniques. Use the following tips to for are healthier options.

**Tip #1: Clean your grill before cooking.** Scrubbing your grill with a brush before you cook eliminates any build-up from charring and makes your food taste better.

**Tip #2: Grill veggies and fruit – not meat .** Add colorful vegetables and fruit to the grill. Many of the chemicals(HCA's) that are created when meat is grilled are not formed during the grilling of vegetables or fruits, so you can enjoy grilled flavor worry-free. They're also naturally low in fat and usually need only a short time over heat to gain terrific smoky flavor. Red, yellow, and green peppers, yellow squash, mushrooms, red onions, pineapple – all of these veggies grill well and make healthy additions to your plate. Adding these fresh foods to your meals also makes them more heart-healthy. Boost flavor not carcinogens!

**Tip #3: Avoid Charring meat and choose lean meats, trimmed of excess fat.** Line the grill with foil and poke small holes in it so the fat can still drip off, but the amount of smoke coming back onto the meat is lower. Choose meats such as buffalo or elk that are leaner than beef. For poultry, choose white breast meat without the skin, however know chicken breast forms the highest level of HCA's when grilled. Select lean cuts of beef such as round, sirloin and tenderloin. For ground meats, go with the 90% lean cuts buffalo or beef and ask your butcher to grind them for you. Be sure to trim all excess fats before grilling to reduce HCAs and PAHs.

**Tip #4: Use marinades that contain vinegar or citrus.** Marinating meat for 30 minutes up to even an hour or two will help decrease the formation of HCA. The best marinades contain three primary ingredients: oil, acid such as vinegar or citrus juice and dried herbs. Thicker marinades and marinades containing a lot of sugar tend to char and cause higher levels of HCA to form. Try my [Healthy Meat Marinade](#) to reduce the carcinogenic effects of grilling and keep low-fat meats tender and juicy.

**Tip #5: Pre-cook before grilling.** Cook meat or fish for a minute or two in the microwave before grilling to reduce the time on the grill and the amount of juices released during grilling.

**Tip #6: Turn down the heat.** HCAs start to form at 325 degrees Fahrenheit, so once you've preheated your grill, turn down the heat. Grill smaller, thinner cuts of meat (think kebabs) and use an instant-read thermometer so you know when the meat is done.

**Tip #7: Avoid flare-ups and don't overcook.** Flare-ups and overcooking cause charring and charring is the single biggest source of HCAs and PAHs. Despite your best efforts, if charring happens, be sure to cut off any black bits before serving.

Here's a healthy recipe to try! Bon Appetite!

### Grilled Vegetables

- 1 cup fat-free Italian dressing
- 1 small eggplant, sliced lengthwise into ½-inch slices
- 2 medium zucchini, sliced lengthwise into ½-inch slices
- 2 medium summer squash, sliced lengthwise into ½-inch slices
- 2 red peppers, cored, seeded, and sliced into ½-inch rings
- 2 green peppers, cored, seeded, and sliced into ½-inch rings
- 2 yellow peppers, cored, seeded, and sliced into ½-inch rings
- ½ head fennel, leaves removed, cut into 4-inch pieces

Toss vegetables with olive oil to lightly coat, add 1 tablespoon minced garlic, keeping each type of vegetable separate. Heat grill to medium-high heat.

Skewer vegetables (or cook in grilling basket to prevent small items from falling onto coals or heating element). Grill until tender and lightly browned: 1 to 2 minutes per side for peppers, 2 to 3 minutes per side for eggplant and squashes, and 3 to 4 minutes per side for fennel. Sprinkle with garlic salt while cooking.

Remove from grill and place on a large platter, separating each type of vegetable.

Serves 8. *Approximate per serving: 80 calories, 0 grams of fat*

### ***For those in medical professions see below from the National Cancer Institute:***

**What evidence is there that HCAs and PAHs in cooked meats may increase cancer risk?**

Studies have shown that exposure to HCAs and PAHs can cause cancer in animal models (6). In many experiments, rodents fed a diet supplemented with HCAs developed tumors of the breast, colon, liver, skin, lung, prostate, and other organs (7–12). Rodents fed PAHs also developed cancers, including leukemia and tumors of the gastrointestinal tract and lungs (13). However, the doses of HCAs and PAHs used in these studies were very high—equivalent to thousands of times the doses that a person would consume in a normal diet.

Population studies have not established a definitive link between HCA and PAH exposure from cooked meats and cancer in humans. One difficulty with conducting such studies is that it can be difficult to determine the exact level of HCA and/or PAH exposure a person gets from cooked meats. Although dietary questionnaires can provide good estimates, they may not capture all the detail about cooking techniques that is necessary to determine HCA and PAH exposure levels. In addition, individual variation in the activity of enzymes that metabolize HCAs and PAHs may result in exposure differences, even among people who ingest (take in) the same amount of these compounds. Also, people may have been exposed to PAHs from other environmental sources, such as pollution and tobacco smoke.

Nevertheless, numerous epidemiologic studies have used detailed questionnaires to examine participants' meat consumption and meat cooking methods to estimate HCA and PAH exposures. Researchers found that high consumption of well-done, fried, or barbecued meats was associated with increased risks of colorectal (14), pancreatic (15, 16), and prostate (17, 18) cancer.

### Do guidelines exist for the consumption of food containing HCAs and PAHs?

Currently, no Federal guidelines address the consumption of foods containing HCAs and PAHs. The World Cancer Research Fund/American Institute for Cancer Research issued a report in 2007 with dietary guidelines that recommended limiting the consumption of red and processed (including smoked) meats; however, no recommendations were provided for HCA and PAH levels in meat (19).

### Are there ways to reduce HCA and PAH formation in cooked meats?

Even though no specific guidelines for HCA/PAH consumption exist, concerned individuals can reduce their exposure by using several cooking methods:

- Avoiding direct exposure of meat to an open flame or a hot metal surface and avoiding prolonged cooking times (especially at high temperatures) can help reduce HCA and PAH formation (20).
- Using a microwave oven to cook meat prior to exposure to high temperatures can also substantially reduce HCA formation by reducing the time that meat must be in contact with high heat to finish cooking (20).
- Continuously turning meat over on a high heat source can substantially reduce HCA formation compared with just leaving the meat on the heat source without flipping it often (20).
- Removing charred portions of meat and refraining from using gravy made from meat drippings can also reduce HCA and PAH exposure (20).

### 1. What research is being conducted on the relationship between the consumption of HCAs and PAHs and cancer risk in humans?

Researchers in the United States are currently investigating the association between meat intake, meat cooking methods, and cancer risk. Ongoing studies include the NIH-AARP Diet and Health Study (14, 21), the American Cancer Society's Cancer Prevention Study II (22), the Multiethnic Cohort (23), and studies from Harvard University (24). Similar research in a European population is being conducted in the European Prospective Investigation into Cancer and Nutrition (EPIC) study (25).

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### Related NCI materials and Web pages:

- [Understanding Cancer Series: Cancer and the Environment](http://www.cancer.gov/cancertopics/understandingcancer/environment)  
(<http://www.cancer.gov/cancertopics/understandingcancer/environment>)
- [What You Need To Know About™ Cancer](http://www.cancer.gov/cancertopics/wyntk/cancer)  
(<http://www.cancer.gov/cancertopics/wyntk/cancer>)