

Taking good advantage of the BBQ

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One of the great pleasures of summertime is being able to finally cook outside on the BBQ. It should, however, be borne in mind that cooking meats at high temperatures leads to the formation of carcinogenic substances and that certain very simple precautions allow us to reduce the harmful effects associated with these toxic substances.

The cooking of meat encompasses a chain of chemical reactions which generate thousands of remarkably fragrant molecules, along with hundreds of volatile substances produced by the reaction of sugars with proteins from the meat. Some of these molecules possess an odor reminiscent of fruits, others those of mushrooms or even of nuts. Collectively, they become integrated by our brains into the sensation of a new odor, unknown in nature but which exists thanks to the culinary arts: the incomparable aroma produced by the cooking of a piece of meat. The cooking of meat also releases both glutamate and inosinate, two molecules which are detected by the umami taste receptors located with the other taste receptors on the tongue, which signal to the brain the presence of a food rich in proteins and activates the pleasure and reward regions of the brain. It's not for nothing that BBQ is so popular!

CARCINOGENIC SMOKE

However, the cooking of meats at high temperature (>400° F) also produces the formation of two large classes of toxic molecules, namely 1) heterocyclic amines, formed from the creatine present in large quantities within the muscle cells of meat which chemically links to amino acids in the proteins and 2) polycyclic aromatic hydrocarbons (PAHs), present in the smoke produced from the fats and juices which flow during cooking and which then adhere to the surface of the meat. Several studies have shown that these two classes of chemical compounds are carcinogenic. Epidemiological studies which were centred on this topic have also shown that elevated consumption of carbonized meat is associated with an increased risk for certain types of cancers (most notably pancreas, colon and prostate).

PASSIVE ABSORPTION

A recent study showed that the smoke generated by cooking at high temperatures also contains combustion by-products, such as PAHs, and could thus contribute to the toxicity of these molecules by being absorbed by the lungs or even by the skin.

To compare the levels of toxins absorbed by these three routes (food, lungs and skin), a team of Chinese scientists separated 20 volunteers into three groups:

1. In the first group, the participants were exposed to total HAPs, i.e. those present in the foods, in the fumes inhaled during cooking as well as in the smoke which came into contact with the skin;
2. In the second group, the participants were only exposed to the HAPs present in the smoke (absorbed by lungs and skin), i.e. they were exposed to the smoke about the BBQ in the same way as was the first group, but they were served boiled meat rather than grilled meat for their meal;



3. In the third group, the participants wore protective masks connected to cylinders of compressed air to prevent inhaling the fumes from cooking and were thus only exposed to the PAHs which came into contact with their skin.

By measuring the quantities of PAHs in the urine of participants (a measure of exposure to these toxins), the authors confirmed, unsurprisingly, that the main route of exposure to PAHs were via the food, with about 90% of the toxins being absorbed¹. On the other hand, they made the surprising discovery that the skin is the second source of exposure. According to the authors, it is likely that the presence of fats in the smoke from BBQs facilitates absorption of toxins by the skin. Subsequent experiments also suggested that clothes exposed to smoke from BBQs accumulated carcinogenic molecules, which can then come into direct contact with the skin and diffuse into the blood circulation.

REDUCE EXPOSURE

For BBQ enthusiasts, it is possible to limit exposure to carcinogenic substances. For one thing, nearly all heterocyclic amines can be eliminated by marinating the meat in the presence of virgin olive oil, garlic and lemon juice, or with aromatics such as thyme or rosemary². Marinades that are more Asian in nature, such as those composed of teriyaki sauce or even curcuma, also diminished by a third the production of heterocyclic amines and thus are very interesting alternatives³. Even those who are rushed for time can reduce the heterocyclic amines by about half simply by adding curcuma (0.2%) to ground beef before cooking it⁴ as the curcuminoid molecules inhibit the production of amines. The possibilities are infinite and confirm the ancestral wisdom of Antillean cooking traditions, which always use meats marinated in the presence of spices and aromatics for what they called *barbacoa*.

- (1) Lao JY et al. Importance of dermal absorption of polycyclic aromatic hydrocarbons derived from barbecue fumes. *Environ. Sci. Technol.*, published online May 23 2018.
- (2) Gibis M. Effect of oil marinades with garlic, onion, and lemon juice on the formation of heterocyclic aromatic amines in fried beef patties. *J Agric Food Chem.* 2007; 55: 10240-7.
- (3) Nerurkar PV et al. Effects of marinating with Asian marinades or western barbecue sauce on PhIP and MeIQx formation in barbecued beef. *Nutr Cancer* 1999; 34: 147-52.
- (4) Puangsombat K et al. Inhibitory activity of Asian spices on heterocyclic amines formation in cooked beef patties. *J Food Sci.* 2011; 76: T174-80.