

Cancer Association of South Africa (CANSA)



Fact Sheet on Dangers of Meats Cooked at High Temperature

Introduction

Recent research has shown that cooking certain meats at high temperature creates chemicals that are not present in uncooked meats. Some of these chemicals may increase the risk of cancer.

Among these chemicals are Heterocyclic Amines (HCAs) a carcinogenic (cancer causing) chemical formed during the cooking of muscle meats such as beef, pork, fowl, and fish. Heterocyclic amines form when the building blocks of proteins (amino acids) and a specific chemical found in muscles (creatine) react at high cooking temperatures.

There are 17 different HCAs which result from the cooking of muscle meats that may create a human cancer risk (Zheng & Sang-Ah: 2010).



[Picture Credit: Braaivleis]

Another harmful chemical also formed when muscle meat is cooked at high temperatures is Polycyclic Aromatic Hydrocarbons (PAHs).

High temperature cooking includes pan frying or grilling directly over an open flame. Sugars which may be present in certain marinades may also form HCAs and PAHs during high temperature cooking of meats (National Cancer Institute, 2010).

New research led by the University of California, San Francisco (UCSF), offers further evidence of a link between aggressive prostate cancer and consumption of well-done red meat (Paddock, 2011).

Carcinogenicity of Consumption of Red and Processed Meat

In October 2015, 22 scientists (the Working Group) from ten countries met at the International Agency for Research on Cancer (IARC) in Lyon, France. They evaluated the carcinogenicity (cancer causing ability) of red meat and processed meat.

Red meat refers to unprocessed mammalian muscle meat – for example, beef, veal, pork, lamb, mutton, horse, or goat meat – including minced or frozen meat – which is generally consumed cooked.

Processed meat refers to meat that has been transformed through salting, curing, fermentation, smoking, or other processes to enhance flavour or improve preservation. Most processed meats contain pork or beef, but may also contain other red meats, poultry, offal (e.g. liver), or meat byproducts such as blood.

The Working Group assessed more than 800 epidemiological studies that investigated the association of cancer with consumption of red meat or processed meat in many countries, from several continents, with diverse ethnicities and diets. For the evaluation, the greatest weight was given to prospective cohort studies done in the general population. High quality population-based case-control studies provided additional evidence.

Processed Meat Classified as Carcinogenic to Humans (Group 1)

Overall, the Working Group classified consumption of processed meat as ‘carcinogenic to humans’ (Group 1) on the basis of sufficient evidence for colorectal cancer. Additionally, a positive association with the consumption of processed meat was found for stomach cancer.

Red Meat Classified as Probably Carcinogenic to Human (Group 2A)

The Working Group classified consumption of red meat as ‘probably carcinogenic to humans’ (Group 2A). In making this evaluation, the Working Group took into consideration all the relevant data, including the substantial epidemiological data showing a positive association between consumption of red meat and colorectal cancer and the strong mechanistic evidence. Consumption of red meat was also positively associated with pancreatic and with prostate cancer. (IARC).

How Processed and Red Meat Cause Cancer

Researchers are still trying to pin down exactly *how* red and processed meat cause cells to become cancerous, but the main culprits seem to be certain chemicals found in the meat itself.

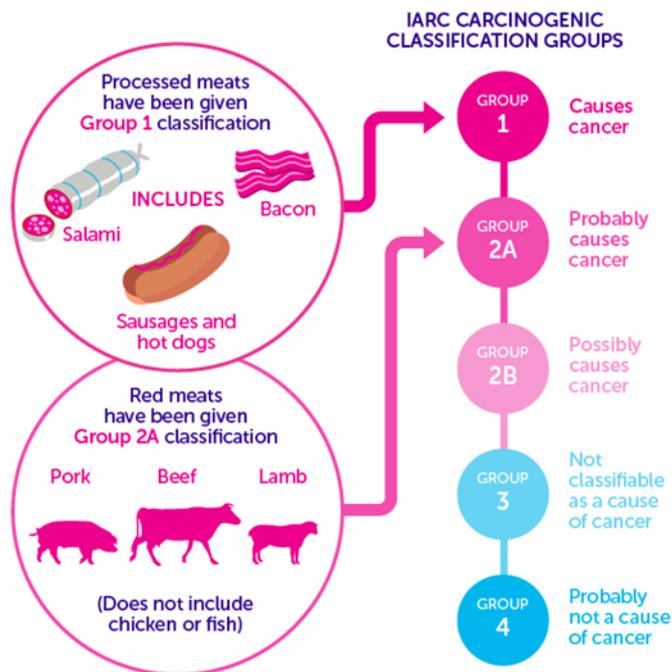
In red meat, the problems seem to start when a chemical called haem - part of the red pigment in the blood, haemoglobin - is broken down in our gut to form a family of chemicals called N-nitroso compounds. These have been found to damage the cells that line the bowel, so other cells in the bowel lining have to replicate more in order to heal. And it is this ‘extra’ replication that can increase the chance of errors developing in the cells’ DNA – the first step on the road to cancer.

On top of this, processed red meats contain chemicals that generate N-nitroso compounds in the gut, such as nitrite preservatives.

Cooking meat at high temperatures, such as grilling or barbequing, can also create chemicals in the meat that may increase the risk of cancer. These chemicals are generally produced in higher levels in red and processed meat compared to other meats.

So despite what you may hear, it is not about the quality of the meat, or whether it is from the local butcher or your supermarket. The evidence so far suggests that it is probably the processing of the meat, or chemicals naturally present within it, that increases cancer risk.

MEAT AND CANCER HOW STRONG IS THE EVIDENCE?



These categories represent how likely something is to cause cancer in humans, not how many cancers it causes.

[Picture Credit: Meat and Cancer]

(Cancer Research UK).

Heterocyclic Amines and Polycyclic Aromatic Hydrocarbons



Heterocyclic Amines (HCAs) and Polycyclic Aromatic Hydrocarbons (PAHs) are chemicals which form when certain muscle meats, such as pork, beef, poultry or fish, are cooked at high temperatures during pan frying or direct grilling over an open flame. These chemicals can also form when cooking meat in a typical South African 'braai' (barbeque) over a charcoal or wood fire when fat and juices from the meat drip onto the fire, causing flames and smoke (Cross & Sinha, 2004). Smoked meats, therefore, are also harmful to consume.

[Picture Credit: Smoked Meat]

HCAAs are usually not found in significant amounts in foods, other than meat cooked at high temperatures whereas PAHs may be present in other charred foods, as well as in cigarette smoke and car exhaust fumes (National Cancer Institute, 2010).

Numerous epidemiological studies made use of detailed questionnaires to determine participants' meat consumption patterns and methods used to cook their meat in order to estimate their exposure to HCAAs and PAHs. Research has shown that high consumption of well-done, fried, or barbecued meats was associated with increased risk of colorectal cancer (Cross, *et al.*, 2010), pancreatic cancer (Stolzenberg-Solomon, *et al.*, 2007), and prostate cancer (Sinha, *et al.*, 2009).

Advanced Glycation End Products

Advanced Glycation End Products (AGEs) are the end-products of glycation reactions, in which a sugar molecule bonds to either a protein or lipid (fat) molecule without an enzyme to control the reaction. When proteins are cooked with sugars in the absence of water, AGEs are formed. Water, however, prevents these sugars from binding to the protein molecules. One may only think of meat when hearing the word 'protein'. When reading up on AGEs, it becomes clear that grains, vegetables, fruits, and such all have protein in them as well, with browning during cooking being an indication of the presence of AGEs.

The half-life of AGEs is about double that of the average cell in one's body and the human body can only deal with AGEs very slowly – AGEs tend to build up in the human body after consumption and are implicated in many age-related and chronic disease such as:

- Cancer
- Type II diabetes mellitus
- Cardiovascular diseases
- Alzheimer's disease
- Peripheral neuropathy
- Deafness
- Blindness

(Ansari & Rasheed, 2010; Naked Food Cooking).

Protective Measures when Having a Braai

There are currently no guidelines addressing the consumption of HCAAs, PAHs and AGEs. However, the National Cancer Institute (2010), The Cancer Treatment Centers of America, and Dr NAlini Chilkov in the Huffington Post, provide the following information whereby individuals can reduce their exposure to the mentioned harmful chemicals.

The following are their recommendations:

- Prepare the grill properly – the smoke from the grill contains potential carcinogens (cancer causing chemicals). 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
- Avoid direct exposure of meat to an open flame
- Avoid exposure of meat to a hot metal surface
- Avoid prolonged cooking times of meat

- Braai with less intense heat and use lower temperatures with all cooking methods
- Use charcoal briquettes, which burn at lower temperatures
- Keep the grill clean
- Scrape off all the charred residue every time you braai so that you do not transfer carcinogenic chemicals to the meat the next time the grill is used
- Avoid well-done meats
- Defrost all meat before braaiing
- Avoid having flames come into direct contact with the meat
- Remove the meat from the grill as soon as it is cooked
- Use microwave cooking to cook meat prior to exposure to high temperatures – this reduces the time that the meat needs to be in contact with high heat to finish the cooking during a 'braai'
- Marinated meats produce less HCAs and PAHs when braaiied. Some research shows that marinating meats not only makes them taste better, but also reduces the production of carcinogens
- Marinades include canola oil, olive oil, soy sauce, vinegar, mustard, lemon juice, orange juice, garlic, salt, pepper, cooking wine, herbs and spices
- Continuously turn the meat over while it is exposed to a high heat source – this substantially reduces HCA formation
- Remove charred portions of meat before eating. This contains the highest concentration of HCAs. One research study found that eating charred, well-done meat on a regular basis may increase one's risk of pancreatic cancer by up to 60%. Other research suggests heavily charred meats have been linked to colorectal, stomach and breast cancers
- Refrain from using gravy made from meat drippings
- Eat vegetables and fruits raw, boiled, or steamed – when eating raw, there is no formation of HCAs or PAHs because there is no cooking, while boiling and steaming introduce water to the cooking process
- Avoid processed carbohydrates and browned foods – many food manufacturers take steps to increase caramelisation and browning in their foods, directly increasing the levels of AGEs in the foods
- Remove caramelised chicken skin before eating chicken that was grilled or cooked over an open flame
- Cook meats slowly on low temperature – higher temperatures produce more AGEs than lower temperatures and longer cooking times. Cook smaller pieces, which cook more quickly and at lower temperatures.

[Picture Credit: Braai on Low Temperature]



- Choose lean meat – select lean proteins like skinless chicken or turkey breast, flank steak and fish such as salmon, tuna and shrimp. When you do braai meat, trim any excess fat from the meat, as less fat means less smoke.
- Limit portion size of meat – smaller portions of meat will cook quicker with less chance of the formation of AGEs or HCAs
- Rare and medium-rare meats will have fewer AGEs than fully cooked meats, like in a 'braai' (barbeque) or a well-done steak
- Avoid eating processed meats

[Picture Credit: Processed Meat]

- If you choose to eat processed meats (rather avoid them), choose those with the lowest level of HCAs and PAHs
- Buy only 'uncured' varieties of processed meats
- Choose processed meat varieties that say 100% beef, 100% chicken, etc
- Avoid meat products that contain MSG (Monosodium glutamate), high-fructose corn syrup, preservatives, artificial flavours or artificial colouring
- Ideally, purchase sausages and other processed meats from a local farmer who you can ask about the ingredients



Eat More Colourful Fruits and Vegetables

Plant-based diets contain the fewest cancer promoters. Plant-based diets also provide an abundance of cancer-fighting plant chemicals. Plant-based diets reduce oxidative stress that leads to DNA damage. Plant-based diets lead to lower levels of inflammation which is an environment that is protective to the cells and the DNA, inhibiting cancer rather than promoting it.

- Try grilling vegetables and fruits, which do not form cancer-causing chemicals even when cooked at high temperatures
- Try grilled asparagus, bell peppers, carrots, zucchini, eggplants, onions, portobello mushrooms, even mangoes brushed with a little olive oil. Try soy burgers and veggie burgers instead of meat
- Use healthy flavouring – using certain marinades and spices when cooking food on the grill can decrease HCA formation by up to 96%. For meats that are difficult to marinate, try kneading in herbs and spices with known health benefits to help block the formation of harmful chemicals. Turmeric, for example, contains an antioxidant with potential anti-cancer properties. A citrus marinade has vitamin C to protect the meat from forming cancer-causing compounds. Other options include: cumin, cinnamon, oregano, rosemary, mint, dill, cilantro, sweet basil, thyme, tarragon and lemon balm

How Much HCA and PAH can One Safely Consume?

Studies are currently being conducted to assess the amount of HCAs and PAHs in the average diet, but at present the maximum "safe" daily intake of HCAs and PAHs in food has not been established. At the moment there is no good measure of how much HCAs and PAHs would have to be eaten to increase cancer risk, and there are few guidelines concerning consumption of foods with HCAs and PAHs. Further research is needed before such recommendations can be made.

However, concerned individuals can reduce their exposure to HCAs by following the above recommendations and by:

- varying the methods of cooking meats;

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April 2017

- microwaving meats more often, especially before frying, broiling, or braai (barbecuing); and
- refraining from making gravy from meat drippings.

How to Braai Fruits and Vegetables

- Use a light brushing of canola oil on vegetables and fruits to help prevent sticking. The use of a non-stick grate or foil packets lightly coated with canola oil can also be helpful

- As a general rule, do not peel vegetables before braaiing – there are more nutrients present when unpeeled veggies are used. Leave the husk on the mealie cob to act as a natural insulator, keeping the steam in and preventing the mealie from drying out

[Picture Credit: Braaiing Vegetables]



- Most fruits generally do not need to be peeled prior to grilling
- Some veggies (including artichokes, asparagus, beets, broccoli, carrots, parsnips, potatoes and winter squash) can be pre-cooked to shorten grilling time and ensure that the inside and outside cook evenly. To pre-cook: steam or blanch until just barely tender. Then, pat dry, brush lightly with canola or olive oil and grill until completely tender and very lightly browned

- Veggies like eggplant, fennel, onions, mushrooms, peppers, sweet potatoes, summer squash and tomatoes should be raw when placed on the grill

- Grilling fruits should be ideally firm and barely ripe. Watermelon, pineapple, apples, peaches and pears can all take the heat. Soak them in a nice sweet non-alcoholic wine or drizzle them with honey before lightly braaiing for an added burst of flavour

[Picture Credit: Braaiing Fruit]



- Cook all fruits and vegetables directly over moderately hot coals or use the indirect heat method. Rotate them or move them to a cooler part of the grill during cooking as necessary to ensure that the outside is not cooking too quickly.
(Whole Foods Market).

Try This Sweet Potato Braai!

Here is something very special to try out:

Ingredients:

- 4 medium to large sweet potatoes - well scrubbed

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- Sea salt to taste
- 1 teaspoon ground cumin
- 1 teaspoon paprika
- ½ teaspoon ground cinnamon
- Brown sugar to taste
- 2 tablespoons cider vinegar
- ¼ cup extra-virgin olive oil



[Picture Credit: Sweet Potatoes]

Method:

Cover sweet potatoes with cold salted water in a large pot - bring to a boil. Simmer until sweet potatoes are slightly resistant when pierced with a sharp small knife (about 5 to 7 minutes). Drain well. When cool, slice them lengthwise.

Mix together salt, sugar, spices and apple cider vinegar; add olive oil or canola oil in a slow stream. Brush this mixture onto the sweet potatoes.

Grill them on a lightly oiled grill rack over medium heat, until grill marks appear and the sweet potatoes are cooked through, about 15 minutes.

Serve them warm (with a little bit of honey) and enjoy something very special!
(Whole Foods Market).

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