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The Case Against Charred Foods

Analysis by Dr. Joseph Mercola | January 29, 2024

STORY AT-A-GLANCE

- Acrylamide is created when carbohydrate-rich plant foods are cooked at high temperatures, whether baked, fried, roasted, grilled or toasted
- Animal studies have shown that acrylamide increases the risk of several types of cancer, and the International Agency for Research on Cancer (IARC) considers acrylamide a "probable human carcinogen"
- Acrylamide is found in 40% of calories consumed by the average American. The FDA recommends limiting acrylamide exposure by avoiding fried foods and toasting or cooking bread and potatoes to a light golden color rather than dark brown or blackened

Editor's Note: This article is a reprint. It was originally published February 8, 2017.

In 2002, researchers discovered a cancer-causing and potentially neurotoxic chemical called acrylamide is created when carbohydrate-rich foods are cooked at high temperatures, whether baked, fried, roasted, grilled or toasted.

Acrylamide is the byproduct of a chemical reaction between sugars and the amino acid asparagine, which occurs at high temperatures. While the chemical can form in many foods cooked or processed at temperatures above 250 degrees F (120 degrees C), carbohydrate-rich foods are by far the most vulnerable.

As a general rule, acrylamide forms when plant-based foods are heated enough to produce a fairly dry and "browned" or charred surface,[1,2] hence, it's most readily found in:[3]

- **Potatoes —** Chips, french fries and other roasted or fried potato foods
- **Grains —** Bread crust, toast, crisp bread, roasted breakfast cereals and various processed snacks such as crackers and cookies
- **Coffee;** roasted coffee beans and ground coffee powder. Surprisingly, coffee substitutes based on chicory actually contains two to three times more acrylamide than real coffee
- **Cocoa products**

Acrylamide Is Common in Standard American Diet

In November 2013, the U.S. Food and Drug Administration (FDA) issued a consumer update[4] advising people to reduce consumption of foods in which acrylamide is plentiful, noting this toxic byproduct is found in 40% of calories consumed by the average American.

To cut acrylamide from your diet, the agency recommends avoiding fried foods, and toasting or cooking items such as bread and potatoes to a light golden color rather than dark brown or blackened. Also, don't store potatoes in your fridge, as the chilling actually increases acrylamide levels during cooking.[5]

This effect is due to starch turning into sugar faster when the potato is exposed to lower temperatures. The taste of the potato can also be adversely affected for the same reason. (Frozen foods, on the other hand, do not carry this risk as sugars are not broken down at freezing temperatures.)

Store potatoes in a dark, dry closet or pantry instead. You can further reduce acrylamide formation by soaking the potatoes in water for 15 to 30 minutes before cooking.

While the FDA makes no mention of avoiding processed foods containing potatoes and grains in general, that's another no-brainer, as many are processed at high temperatures and therefore may contain acrylamide.

Acrylamide Linked to Cancer in Animals

Animal studies have shown that acrylamide increases the risk of several types of cancer, and the International Agency for Research on Cancer (IARC) considers acrylamide a "probable human carcinogen." According to a 1988 study:[6]

> *"The data show that acrylamide is capable of inducing genotoxic, carcinogenic, developmental and reproductive effects in tested organisms. Thus, acrylamide may pose more than a neurotoxic health hazard to exposed humans.*
>
> *Acrylamide is a small organic molecule with very high water solubility. These properties probably facilitate its rapid absorption and distribution throughout the body.*
>
> *After absorption, acrylamide is rapidly metabolized, primarily by glutathione conjugation, and the majority of applied material is excreted within 24 hours … Acrylamide can bind to DNA … which has implications for its genotoxic and carcinogenic potential."*

Human Cancer Studies Show Mixed Results

In humans, the results appear more mixed. A study[7] published in 2007 linked higher dietary acrylamide intake with an increased risk of endometrial and ovarian cancer in postmenopausal women, particularly among non-smokers.

A 2009 study[8] also found that higher acrylamide intakes were associated with a higher risk of certain types of breast cancer compared to lower intakes — specifically breast cancers that are estrogen and progesterone receptor positive.

However, the association was minor, and no association was found for overall breast cancer risk or receptor-negative breast cancer. Acrylamide has also been linked to nerve damage and other neurotoxic effects, including neurological problems in workers handling the substance.

On the other hand, a 2015 review[9] concluded dietary acrylamide is unrelated to cancer risk for most common cancers, with the exception of kidney cancer, for which they found a "modest association."

They also noted that among non-smokers, "dietary acrylamide appeared to slightly increase risk of endometrial and ovarian cancer as well." Still, concern about acrylamide in the diet appears to be growing, not settling.

The United Kingdom's Food Standards Agency (FSA) launched a "Go for Gold" campaign[10,11] aimed at reducing dietary acrylamide exposure, noting that "the scientific consensus is that acrylamide has the potential to cause cancer in humans."

And, as noted by George Alexeeff, Ph.D., deputy director for scientific affairs at the Office of Environmental Health Hazard Assessment (OEHHA), which oversees implementation of California's Proposition 65:

> *"We definitely believe acrylamide is a chemical to be concerned about. Our general presumption is that unless there's some other evidence, we assume that if something causes cancer in animals, it causes cancer in humans."*

Acrylamide Levels in Food Often Surpass Legal Limits for Water

The federal limit for acrylamide in drinking water is 0.5 parts per billion (ppb), or about 0.12 micrograms (mcg) in an 8-ounce glass of water. Meanwhile, a 6-ounce serving of french fries can contain 60 mcg acrylamide.

That's about 500 times the allowable limit for drinking water. It seems a bit odd that something that would be toxic in drinking water would suddenly be harmless in food.

Unfortunately, while the Environmental Protection Agency (EPA) regulates acrylamide in drinking water and the FDA regulates the amount of acrylamide residue in materials that may come in contact with food, they do not currently have any guidelines limiting the chemical in food itself, though they should.

A 2002 food analysis published in the Journal of Agricultural and Food Chemistry[12] found moderate levels of acrylamide (5 to 50 mcg/kg) in heated protein-rich foods and higher levels (150 to 4,000 mcg/kg) in carbohydrate-rich foods.

Unheated or boiled foods showed undetectable levels (<5 mcg/kg) of acrylamide, leading the researchers to conclude that: "Consumption habits indicate that the acrylamide levels in the studied heated foods could lead to a daily intake of a few tens of micrograms."

Whether or not such levels are safe is still largely unknown, but I would vote for taking a precautionary approach and limiting your exposure as much as possible. It's really not a good idea to consume known toxins, even in minute amounts.

Worst Offender: Potato Chips

Potato chips are among the worst offenders, by far.[13] So much so that in 2005 the state of California sued[14] potato chip makers for failing to warn California consumers about the health risks of acrylamide in their products. The 2005 report "How Potato Chips Stack Up: Levels of Cancer-Causing Acrylamide in Popular Brands of Potato Chips," issued by the California-based Environmental Law Foundation (ELF), spelled out the dangers of this popular snack.

According to their analysis, ALL potato chip products tested exceeded the legal limit of acrylamide by a minimum of 39 times, and as much as 910 times! Interestingly, FDA data reveals that baked chips, which are often touted as a healthier chip, can contain more than three times the level of acrylamide in regular chips.[15]

A settlement between California and the potato chip makers was reached in 2008[16] when Frito-Lay and several others agreed to reduce the acrylamide levels in their chips to 275 ppb by 2011, which is low enough to avoid needing a Prop. 65 cancer warning label.

How to Make a Safer Potato Dish

While french fries tend to be among the most popular potato dishes, this is perhaps one of the worst ways to eat your potatoes. Not only do you have acrylamide to contend with, but unless you're frying them in coconut oil or lard, you're also getting a hefty dose of harmful vegetable oil. This doesn't mean you have to forgo potatoes altogether though. By storing and preparing them correctly, potatoes can still be a healthy addition to your diet.

The key is to prepare them in such a way that you increase the digestive-resistant starch in the potatoes. (As mentioned earlier, be sure to store them in a cool, dry place, such as your pantry, rather than your refrigerator. When potatoes are stored cold, greater amounts of acrylamide are produced during cooking.)

Digestive-resistant starches — found in unripe fruits such as **bananas**, papayas and **mangoes**, as well as white beans, lentils, seeds, tapioca starch, brown rice flour, chilled cooked potatoes and even chilled cooked pasta[17] — are fibers that resist digestion in the small intestine and slowly ferment in your large intestine, where they act as prebiotics that feed healthy bacteria.[18,19]

Importantly, since they're not digestible, resistant starches do not result in blood sugar spikes. In fact, research suggests resistant starches help improve insulin regulation, reducing your risk of insulin resistance.[20,21,22,23] Resistant starch may also facilitate weight loss and is associated with a lower risk of colorectal cancer.[24]

One of the most obvious dishes that come to mind here is potato salad.[25,26] But bean salad, pasta salad and quinoa salad will also contain resistant starch. The total amount of resistant starch in the final dish depends on a number of factors, including the amount of resistant starch found in the raw food and the way it was prepared.

For example, roasted and cooled potatoes contain 19 grams of resistant starch per 100 grams, whereas steamed and cooled potatoes contain 6 grams and boiled, cooled potatoes contain a mere 0.8 grams.[27,28]

While you can also use sweet potatoes, regular potatoes have more resistant starch to begin with, and create more retrograde starch — the resistant starch created when the

potatoes are cooled after cooking. Potatoes that have been cooked and chilled, and then reheated again contain 1.07 grams of resistant starch per 100 grams; hot potatoes (that have not been chilled) contain just under 0.6 grams, whereas sweet potatoes contain a mere 0.08 grams of resistant starch.[29]

One root vegetable that may offer the best of both worlds is the lesser yam. It has both a superior nutritional value overall,[30] and produces more retrograde starch when cooked and cooled than sweet potato and regular potato.[31] Food.com offers a simple yam salad recipe.[32] To reduce net carbs, I'd leave out the sweet relish. I also recommend swapping the vegetable oil for avocado oil.

To know how to properly bake potato and reap some of its benefits, read my article entitled "**How to Bake Potatoes**."

How to Minimize Your Acrylamide Exposure

Acrylamide has so far only been found in foods heated above 250 degrees F/120 degrees C, which includes most processed foods. Basing your diet on whole foods is one of the best ways to avoid this cancer-causing byproduct. For the times when you do cook your food, keep the following tips in mind:

- Frying, baking and broiling appear to be the worst offenders, while boiling or steaming appear to be safer
- Longer cooking times increase acrylamide, so the shorter the duration of cooking, the better
- The darker brown or blackened the food, the more acrylamide it contains, so avoid overcooking your food
- Acrylamide is found primarily in plant-based carb-rich foods such as potatoes and grain products (not typically in meat, dairy or seafood)

For more in-depth information about acrylamide, I recommend reading the online report: "Heat-generated Food Toxicants: Identification, Characterisation and Risk

Minimisation."[33]

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