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Acrylamide and Fried Foods: Should We Freak Out?

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Introduction

Long before the Mayans conquered South America the potato grew high in the Andes Mountains first cultivated by farmers some four thousand years ago. Then in the eighteenth century, Thomas Jefferson himself introduced the French fry to American culture [1]. Since the fry's debut, the McDonald's franchise alone has served them over sixty billion times. Then in April 2002, the Swedish National Food Administration shook the fried food-eating world when it reported finding significant levels of the chemical acrylamide in fried foods particularly potato chips and French fries [2]. They also found lower quantities of acrylamide in corn chips, breakfast cereals, and crisp bread.

Acrylamide is a small organic molecule. Its principle use is in the manufacture of polyacrylamide, which is a gel like substance used in a variety of purposes from industrial to agricultural to consumer. Polyacrylamide is used in water treatment and water purification as well as soil conditioning and food packaging [3]. It is non-toxic. However, acrylamide, before it is turned into polyacrylamide, is a carcinogen and also a neurotoxin [4]. The body itself converts ingested acrylamide to a carcinogenic by-product when attempting to destroy it, and this by-product binds and mutates DNA [5].

Here I will present a brief overview of how acrylamide forms in fried foods. I will also argue that although acrylamide appears to be a carcinogen in laboratory studies with rats, there is no correlation between the consumption of fried foods and the incidence of colon, bladder, or kidney cancer probably because the level of acrylamide in food is too small to have toxic effects.

Acrylamide Formation

Acrylamide is not being added to foods or but rather it is formed when starchy foods are fried. A raw potato for example has negligible levels of acrylamide (<0.030 mg/kg of potato) but if you make potato chips then the level of acrylamide can skyrocket to 1.2 mg/kg of potato chips [2]. French fries tend to have about 0.45 mg/kg of fries.

Two different groups studied how acrylamide forms in these foods and discovered that the amino acid asparagine, a building block of proteins, reacts with sugars and starches to form acrylamide at high temperature. It forms in a process known as a Maillard reaction, which is out of the scope of this review [6]. Interestingly, they found that the food only has to get up to about 350° F (180° C) to form acrylamide in significant quantities. Potatoes are quite high in the amino acid asparagine as well as starch, which may explain why they have the highest levels when compared to other chips such as corn [7].

Frying foods in grease or oil is not required to form acrylamide so long as asparagine and starch or sugar are present together at high temperature even in processes such as baking whereas boiling at 212° F (100° C) was not sufficient to form acrylamide [6]. One possible reason baked potatoes have very little acrylamide compared to potato chips is that the inside of a potato tends to remain near water's boiling point and only the very outer surface of the potato reaches the higher oven temperature [personal experiment with a baked potato and a meat thermometer].

Affect of Acrylamide on Rats

One group studied acrylamide by adding large quantities of acrylamide to rats and observing rate of tumor formation. They found that exposure to heavy amounts of acrylamide was sufficient to increase the risk of cancer in laboratory rats [4].

A second group studied the affects of chronic acrylamide exposure by adding it to the drinking water of rats. They added 2 mg/kg body weight of acrylamide to the water every day for two years. For comparison's sake, a dose of extra strength aspirin is 9 mg/kg body weight [8]. They demonstrated that rats at this level of acrylamide showed a slight increase in the risk of developing a tumor but not in a statistically significant amount compared to rats that received no acrylamide [9]. This would suggest that although acrylamide is classified as a carcinogen, 2 mg/kg body weight per day for 2 years did not significantly raise the risk of developing a tumor. Whether longer exposure to this level for possibly 10 years or more would increase the risk is still not known and would have to be investigated.

Does Acrylamide Matter to Us?

To answer this question, a study was conducted to investigate whether people who ate these fried foods such as potato chips in large quantities, which have acrylamide, were at any increased risk of developing cancer than individuals who stayed clear of these foods. Individuals who consumed French fries and potato chips on a greater than weekly basis for at least the past 5 years were not any more likely than those individuals who never ate French fries or potato chips [10]. The authors believe that the levels of acrylamide in food are too low to cause any of the toxic effects of acrylamide.

Let us set 2 mg/kg/day of acrylamide from the rat experiment as the highest acceptable level of daily intake. Let's then take a person who weighs 70 kg (154 lbs.). They can consume 140 mg of acrylamide per day (70 kg x 2 mg/kg). The average French fry has 0.4 mg of acrylamide/kg of fries [2]. That means that a person would have to eat 350 kg of fries per day (140 mg / 0.4 mg/kg) to obtain the level of acrylamide each day in the rat experiments. To put this in everyday terms, one would have to eat approximately 1,800 orders of "Super-Sized McDonald's French Fries" (350 kg / 0.198 kg/order of Super Size Fries) [11] every day to get a level of acrylamide that just slightly, but not significantly, increases the risk of a tumor in rats.

Conclusion

Acrylamide is a potential human carcinogen in high doses. It can be formed during the heating of starchy foods around 350°F (180°C) that also have sufficient levels of asparagine namely potatoes but many other foods as well. However, the heavy consumption of fried foods failed to demonstrate a correlation between foods containing acrylamide and tumors of the colon, kidney, and bladder. A likely explanation is that acrylamide does not exist in sufficient quantities to have toxic or oncogenic effects. Longer studies such as 10 years or more, however, should be done to detect any possible correlation that could have been missed by a 5-year study. Although it is possible that the level of acrylamide in fried foods is not sufficient to cause any harm, fried foods generally have quite a bit of fat, which may lead to heart disease. So although it is tough to show a connection between the acrylamide in fried foods and cancer, heart disease remains the number one killer in the United States and it is well correlated with the excessive intake of fried foods [12].

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