**Coffee: Is it Mutagenic and its Correlation with Cancer**

Author:
Major:
Department of Microbiology and Molecular Genetics, Oklahoma State University, Stillwater, OK 74078, USA

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**Abstract**

According to the Centers for Disease Control and Prevention (CDC), cancer is the second leading cause of death in the United States. Cancer is when a cell has mutated to where it has lost its function and grows uncontrollably. There are many different things that can cause cancer, which is why there are so many kinds of cancer. One of the things that can cause cancer is carcinogens. Carcinogens are any substance that can result in changing normal cells into cancer cells by a process called carcinogenesis. In the 1970s, a biochemist named Bruce Ames created an assay that can test for mutagens, which is an agent that causes genetic altering in the genome. In his findings, Ames found that coffee has a compound, caffeic acid, which can potentially be mutagenic. With that, there have been studies to see if there is a correlation between coffee consumption and cancer. From the studies, there are mixed results, but since there is no clear evidence that proves that drinking coffee causes cancer, coffee is deemed safe to drink.

**Introduction**

Cancer is one of the leading causes of death in the United States. Cancer is a disease in which cells in the body loses the function to stop dividing, thus continuously growing and dividing at an exponential rate creating visible tumors. In addition, these cells can spread onto other cells, making them also lose their function and grow uncontrollably. According to Cancer.gov, about forty percent of the human population will be diagnosed with cancer at some point of their lives (Cancer Statistics, 2020).

 There are several reasons why cancer is one of the leading causes of death in the United States. One reason is that cancer can spread to other parts of the body, which can be difficult to detect. In addition, cancers can grow for years before they are detected. Furthermore, there are many things that can cause or contribute to cancer.

 One of these things is called carcinogens. Carcinogens are anything that can cause cells to become cancerous. These could include things like radiation or substances from food. They promote a process called carcinogenesis, which is the process where cells turn cancerous from mutagenicity. Mutagens are agents that turns cells cancerous by disrupting their cell division cycle or permanently altering the genetic genome of the cell.

 Knowing that carcinogenesis can cause cancer cells through mutagenicity, American biochemist Bruce Ames developed an assay that can test for mutagens, which can find potential carcinogens. He called this the Ames test, from this test, he found that many common household products contain carcinogens. Some common household items that made the list as carcinogens include black pepper, mushroom, celery, mustard, horseradish, and coffee (Weinberg, 2014, pg. 65). The one notable item that will be discussed is coffee. Coffee contains the compound caffeic acid, which is registered as a carcinogen in laboratory animals. According to DealsOnHealth, over one billion individuals consume coffee daily (Deals On Health, 2020). That means about one in eight people in the world consumes coffee on a daily basis. In the United States, about sixty-four percent of adults drink coffee daily, which is about four hundred million people. With that, one may wonder, does coffee cause cancer? Should we avoid drinking coffee to avoid cancer risk? These are important questions as coffee is a beverage that can be found all across the globe.

 With coffee containing a carcinogen, many studies have been conducted to see if there is a correlation with coffee consumption and the development of cancer. After many tests and trials, there has been mixed reviews as these evaluations are limited. Though there is no clear answer yet, more surveys show that coffee has an inverse relationship with cancer. Thus, without clear evidence, the World Health Organization cannot conclude that coffee causes cancer (Mendes, 2018).

**Recent Progress**

One study shows that caffeic acid actually hinders the growth of colon cancer (Forester & Waterhouse, 2010). Another study in the Seguimiento Universidad de Navarra (Sanchez et al., 2020), which evaluated a little under eleven thousand females for two years showed that there were no association between coffee drinkers and the breast cancer risk. In this 2018 study, they took middle aged Spanish female graduates from the Seguimiento Universidad de Navarra (SUN) who do not have breast cancer. They studied the coffee consumption per day for two years. Their results did show that there was a lower risk of breast cancer in women who drink more than one cup of coffee per day, which shows signs of an inverse relationship of coffee consumption and breast cancer.

Another study showed that over ten years, there is an inverse relationship between drinking coffee and mortality, even to those people who drink up to eight cups of coffee per day (Loftfield et al., 2018). This study was taken in the UK taking it’s data from 2006 to 2016. In total, there were just over five hundred thousand participants. The age range was thirty-eight to seventy three years old with a mean age of fifty seven years. The results showed that regardless of the type of coffee (instant, ground, decaffeinated), those who consumed coffee, even upwards of six had a lower mortality than those who did not consume coffee.

 On the other hand, there were two studies that showed there are a correlation between drinking coffee and developing cancer. The first one (Li et al., 2019), tested the dose-response in coffee consumption and pancreatic cancer. The study started in 2018. This was a meta-analysis, meaning that they took data from multiple scientific reports. They searched keywords like coffee consumption, caffeine, and pancreas cancer. They found that a non-linear dose of dose-response had no evidence of correlation with pancreatic cancer. However, they noticed that if you increase the dose-response in the increment of an extra cup of coffee per day, there was a significant increase risk of having pancreatic cancer. The other (Seow et al., 2020) showed that there was an inverse relationship between black tea and the risk of lung cancer. This study was taken place in Singapore from citizens or permanent residents. There were a just over sixty thousand participants from the age range of forty-five to seventy four. The participants were enrolled in this program from the time frames of April 1993 and December 1998. The average amount of time of follow up was about 17.7 years. For green tea, their data showed no significant association with lung cancer. Lastly, their data showed a correlation in the consumption of coffee increased the risk of having lung cancer.

**Discussion**

After many experiments, there is no clear evidence that supports the hypothesis that drinking coffee increases the risk of cancer. If anything, drinking coffee has shown to decrease the risk of cancer. Even though Ames test showed that virtually everything could be potentially carcinogenic, we do not have to avoid these things such as coffee, celery, mushroom, black pepper, etc since around 40% of the compounds show no obvious signs of mutagenicity (Weinberg, 2014). In addition, the Ames test was created in the 1970s, thus there has been over fifty years and there is no concrete evidence that coffee causes cancer.

 In one study that show that there is a correlation between consuming coffee and increasing the risk of cancer, it was surveyed in Singapore. This is significant as smoking in Singapore is very common. These are elements that the studies may not have factored in as there is a high possibility that the people who drink coffee also smoke.

 In the other study that supported that coffee causes cancer, they acknowledged that with different standard sizes of cup in America, Europe and Asia, their data could be inaccurate. In addition, with the meta-analysis data, the researchers chose which experiments was acceptable. They stated that they excluded cases that did not have pancreatic cancer. They also some studies that were excluded without an explanation. With that, this study has a lot of data and participants (just under a million), but they were hand picked by the authors, which means the results could biased as this is subjective to the authors.

 For example, a survey in Japan showed that women who drank an average of three cups of coffee a day had a twenty percent less chance of getting colon cancer (Kashino et al., 2018).
 In conclusion, it is difficult to conclude if coffee does increase the risk of cancer. Without any clear evidence over a long period, we cannot conclude that coffee increases the risk of cancer. Since there are so many different types of cancers and many other factors that causes cancer, it will be tough to get an accurate and fair statement on if coffee does increase the risk of cancer.

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