The Spices of Cancer Protection

For centuries, cultures have used spices to improve health and ward off disease. Research is now helping to unravel how these flavor enhancers may also protect against cancer.

From allspice to turmeric, the hundreds of available spices come packed with phytochemicals, many studied for their cancer-fighting properties. A growing body of research — primarily lab studies — is now zeroing in on the role specific spices may play in reducing cancer risk.

“There is more and more documentation that several compounds in spices have anti-cancer properties,” says John Milner, PhD, Director of the Human Nutrition Research Center at the US Department of Agriculture and co-author of a recent review of spices for cancer prevention.

One reason for the increased interest stems from lab studies demonstrating plausible pathways in which spices may work to reduce cancer risk. “There are several potential mechanisms that go all the way from changing carcinogen metabolism to modifying the microbiome to cell signaling — all changes that would inhibit the growth of a tumor,” says Milner.

The potential for spices to affect cancer risk is an appealing area of study for scientists because spices are non-caloric and eaten in combination with other foods. They are also easily incorporated into many dishes, adding flavor and variety.

There are dozens of spices that have pointed to cancer protection in lab studies, with much of the research in its early phases. Allspice has been shown to reduce inflammation and cell proliferation. Cinnamon has suppressed the growth of the bacterium H. pylori, a major risk factor in gastric cancer. The bioactive component in cumin, thymoquinone, seems to suppress tumor growth in colon, breast and pancreatic cells. Some of the more studied spices include turmeric and garlic.

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Research is emerging in other spices and cancer risk, such as black pepper.

Turmeric

Turmeric stands as one of the most extensively studied spices, with over 1,700 lab studies published over the last few decades. It has been used for centuries to treat numerous inflammation-related disorders, including skin conditions, pain and gastrointestinal problems. There are now clinical trials examining its role in reducing cancer risk.

Turmeric gets its yellow pigment from curcumin, a polyphenol that is the primary phytochemical scientists are investigating for its anticancer potential. In the lab, curcumin modulates cell signaling pathways, suppresses tumor cell proliferation and induces apoptosis of cancer cells. There is evidence that curcumin can suppress inflammation and inhibit tumor survival, initiation, promotion, invasion and metastasis.

The findings from lab studies have led to clinical trials in humans, which are generally small but have generated promising findings. In one trial, for example, five patients with Familial Adenomatous Polyposis (FAP) consumed supplement-level amounts of curcumin and quercetin daily. After six months these patients showed a reduction in the number and size of polyps compared to those on placebo. FAP is an inherited condition that causes hundreds of colon polyps to develop early in life, leading to an increased risk of colorectal cancer.

Safety testing for toxicity and tolerability shows that people can tolerate up to 12 grams per day of curcumin with no ill-effects, which equals approximately 88 teaspoons of turmeric. But the bioavailability of curcumin is poor, meaning only a small fraction consumed reaches the bloodstream and tissues. The low bioavailability is the primary reason why scientists like Dong M. Shin, PhD, Professor of Hematology, Oncology and Otolaryngology at Emory University is investigating curcumin analogs, compounds with an altered chemical structure. Shin, who wrote a review on curcumin and cancer prevention, says curcumin has the properties of an ideal chemopreventive agent.

By developing curcumin analogs with increased bioavailability, it’s possible the compound will be able to “reach the tumor at a high concentration” and have more of an anti-cancer impact.

But low bioavailability does not necessarily mean low effect. Also, says Milner, “an analog is more of a drug effect than a dietary effect…. We don’t know the biological consequence of having a modified compound. And I would rather use a natural compound in the spice itself rather than an unnatural compound.”

Black Pepper

One possible way to increase the bioavailability of curcumin may take adding another spice to the diet: black pepper. Studies suggest piperine, a phytochemical in black pepper, can increase the bioavailability of certain anti-cancer compounds in foods, which may translate into greater anti-cancer protection. Piperine, when tested independently, exhibits anti-inflammatory, antioxidant and anticancer activities in cell studies.

Multiple cancer-related processes may account for spices’ ability to inhibit experimentally induced cancers.

Adapted from: Kaefer CM, Milner JA. Herbs and Spices in Cancer Prevention and Treatment. CRC Press; 2011.
Research from the University of Michigan has found that the combination of curcumin and piperine improves curcumin bioavailability and inhibits breast cancer cell self-renewal. The cancer stem cell theory proposes that a smaller population of cancer stem cells acts as tumor stem cells and sustain the cancer. Cancer stem cells may also be responsible for metastases. Cancer stem cells are especially under study for their sulphur-containing molecules that have biologic activity in the body. Garlic

Although technically a vegetable, garlic is considered a spice because it is typically used for flavoring. Raw garlic is converted to a variety of allyl sulfide compounds that have biologic activity in the body. Research from the University of Michigan has found that the combination of curcumin and piperine improves curcumin bioavailability and inhibits breast cancer cell self-renewal. The cancer stem cell theory proposes that a smaller population of cancer stem cells acts as tumor stem cells and sustain the cancer. Cancer stem cells may also be responsible for metastases. Cancer stem cells are especially under study for their sulphur-containing molecules that have biologic activity in the body.

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Scientist in the Spotlight

Henk De Feyter, PhD

An AICR-funded researcher, Henk De Feyter, PhD, Associate Research Scientist at Yale University School of Medicine, focuses his research on cancer metabolism. Using a novel imaging technique called magnetic resonance (MR) spectroscopy, De Feyter’s studies are shedding light on how metabolic changes and diet may link to helping treat brain tumors.

Q: Can you explain MR spectroscopy?
A: Magnetic resonance spectroscopy (MRS) uses the same machine as magnetic resonance imaging, MRI. From a subject’s perspective the experience of going for an MRI scan versus an MRS scan is indistinguishable. Instead of reconstructing the signal of water molecules to get pictures out of it, MRS makes a spectrum from the signal of molecules other than water. A spectrum is a sort of graph with a bunch of peaks. Those peaks represent various molecules and they scale with the concentration of their molecules: if more of a molecule is present, than the peak is larger.

Q: How are you using this in your research?
A: MR spectroscopy has several applications related to metabolism. We have developed MR methods to study the normal metabolism in the brain, skeletal muscle and liver. We are now moving toward studying brain tumors. In cancer, there are often altered metabolic pathways and/or metabolites and we can detect this with MR spectroscopy.

One can now also use MR spectroscopy to look for specific genetic changes in brain tumors that are related to cancer.

Q: You’re using this technique for your AICR-funded study looking at brain cancer and the ketogenic diet (a high-fat, low-carbohydrate diet), correct?
A: Yes. I’m looking at dietary manipulation and brain metabolism. The idea has been around that we may be able to use diet to treat brain tumors. We are particularly interested in how a ketogenic diet may impact brain tumor development by exploiting the tumor’s inability to metabolize ketone bodies. We’re using MR spectroscopy to detect metabolism of ketone bodies in brain tumors.

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Q: Can you explain what a ketone body is?
A: Ketone bodies are an energy source derived from fat. Our body produces ketone bodies in times of fasting. While the brain is usually a huge consumer of glucose – sugar – during times of fasting the brain can perfectly metabolize ketone bodies as well. The rationale for using the ketogenic diet is that brain tumors, in contrast to the healthy brain, would not be able to metabolize ketone bodies. One could “starve” the brain tumor while preserving the healthy brain’s energy metabolism through ketone bodies.

Q: How did you become interested in metabolism and cancer?
A: I’m from Belgium and began my career as a physical therapist. The program was fun, but I realized it was not what I wanted to do. I decided to go to the Netherlands to study health and movement sciences. There, I focused on exercise physiology. Once at Yale, I focused on brain metabolism and now also brain tumor metabolism. And from the moment I learned how to use MR spectroscopy, that technique has been a constant factor in my research.

Cancer metabolism appears to have many subtle and less subtle changes in metabolism compared to healthy cells. To try to study the metabolic changes in tumors using [imaging] methods seemed an obvious step to me.

Q: What are some future applications for MR spectrometry?
A: If we can manage to transfer what we have learned about the healthy brain to brain tumors, it would be an amazing step. I hope we can apply MR spectroscopy to study brain tumor metabolism in humans. Especially for cancer research and diagnostics, this new application has a lot of potential.

Q: What do you hope your study on ketogenic diet/brain tumors accomplishes?
A: My first aim is to understand more about the ketone body metabolism in tumors because that has been a fundamental aspect in making the case to use the ketogenic diet to treat brain tumors. As we have been using MR spectroscopy to study the human brain, we hope to get enough support to transfer our techniques and study brain tumors in patients.

Science Shorts

Believing but Not Meeting Recommendations

More than half of women who think they are eating healthy and being physically active enough to prevent cancer are not meeting the cancer-preventive diet and/or for daily consumption of fruits and vegetables. Among the women who believed they were eating a cancer-preventive diet, less than 10 percent of these respondents reported eating at least five servings of daily fruits and vegetables, which is the minimum recommended by AICR and the American Cancer Society.

Among the women who believed they were doing enough activity to prevent cancer, less than 40 percent reported being moderately active for 30 minutes five days per week. AICR recommends 30 minutes or more of daily moderate activity to reduce cancer risk.

Following AICR Recommendations to Prevent Aggressive Prostate Cancer

A new study published in Nutrition and Cancer suggests that men have a lower risk of developing an aggressive form of prostate cancer by following at least four of AICR recommendations for cancer prevention, including eating healthy and exercising, with each recommendation lowering the risk.

Researchers gathered the diet and activity habits of approximately 2,200 men ages 40 to 70, who were recently diagnosed with an aggressive form of prostate cancer. Using a point scale, they gauged how closely the men adhered to the 8 (of 10) relevant AICR recommendations.

Adherence to fewer than four of the recommendations predicted a 38 percent increased risk of aggressive tumors compared with adherence to four or more. Each point in a patient’s total adherence score linked to a 13 percent reduction in risk of the cancer.

Sipping Less Calories but Still a Soda per Day

Americans of all ages are sipping fewer calories from sugary sodas, energy drinks and other sweet beverages compared to a decade ago, but still drinking the equivalent of about a can of soda per day on average, about 150 calories, according to a May study published in The American Journal of Clinical Nutrition.

Researchers used data from approximately 51,000 NHANES participants. Between 1999 and 2010, the 2 to 19 year olds were drinking on average 155 calories per day, which is 68 fewer calories than in the 1999-2000 survey. Adults were consuming an average of 151 calories each day, a drop of 45 calories.

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