



American Institute
for Cancer Research

A Closer Look At



ANTIOXIDANTS

CONCEPTS IN
CANCER RESEARCH



What Are Antioxidants?

An antioxidant can be a vitamin, phytochemical, or mineral. Antioxidants neutralize damage to the body's cells and are naturally present in vegetables, fruits, whole grains, beans and nuts.

Research studies have found growing evidence that antioxidants may protect the body's cells from the kind of cell damage that can lead to cancer.

Over the past two decades, scientists have studied antioxidants like vitamins C and E. Other antioxidants being investigated are phytochemicals like beta-carotene (related to vitamin A), lycopene, lutein and resveratrol, as well as the trace mineral selenium.

Foods that have high amounts of antioxidants are often easy to identify, because many are brightly colored. For example, carrots and sweet potatoes have plenty of beta-carotene; bell peppers, strawberries and tomatoes contain vitamin C; tomatoes and watermelon have lycopene; and dark leafy greens like spinach contain lutein. Broccoli has plenty of beta-carotene and vitamin C among its many protective compounds. Blueberries have anthocyanins. Red grapes have resveratrol. Many herbs – including oregano, rosemary and parsley – contain a range of antioxidants.

Why Do Our Bodies Need Antioxidants?

Antioxidants defend the body's cells against molecules called "free radicals."

It's one of life's great ironies: The same oxygen we need to live can also do serious harm over time. Cellular activities that keep us alive also produce destructive oxygen molecules in the highly reactive, unstable form of free radicals.

Free radicals possess an unpaired electron. Pairing this lone electron with another gives the molecule stability. To achieve stability, a free radical scavenges electrons from other molecules, which disrupts their stability in turn. This process can start a chemical chain reaction that produces even more free radicals.

In addition to the free radicals produced by normal body processes as we age, our cells must also contend with free radicals that result from such common hazards as ultra-violet light, X-rays, heat, cigarette smoke, alcohol and some pollutants.

Free radicals can do some good, as well. They have the ability to destroy potentially harmful cells, such as bacteria, that invade the body. But too many free radicals can inflict damage on healthy cells. Research now implicates excess free radicals in a number of diseases, including cancer.



If you're looking for a good source of antioxidants, try the produce section of your local supermarket. Studies show that many antioxidants consumed from whole foods are likely to work with other nutrients and phytochemicals to provide stronger health protection than supplements. Furthermore, claims made about the effectiveness of supplements containing antioxidants have been called into question.

In fact, sometimes supplements in high doses may cause harm. For example, some studies show that vitamin E supplements taken in high doses may cause bleeding when combined with blood-thinning medications. Selenium supplements are toxic at high levels, and too much vitamin C may increase risk for kidney stones and gastric distress in some people. Large quantities of beta-carotene can suppress protective effects from other carotenoids. A well-known study of Finnish male smokers who took beta-carotene supplement pills resulted in higher rates of lung cancer among subjects. Although individual studies like these are not conclusive, they do lead researchers to conduct further studies to answer the additional questions their results have posed.

For example, a damaged cell may not activate its natural cancer-fighting defenses. It also may fail in some of its other chemical functions, or even pass on damaged DNA as it divides into new cells. If uncorrected, damage can accumulate and result in disease.

How Do Antioxidants Work?

Fortunately, antioxidants in our diet can help offset damage caused by free radicals.

Dietary antioxidants function in a variety of ways. They can limit free radical formation, destroy free radicals, stimulate antioxidant enzyme activity and stimulate enzymes' repair activity.

Many scientists believe that a plentiful supply of antioxidants, carrying out different protective roles, may help defend against the cell changes that can lead to cancer.

The Evidence So Far



A number of studies point to an association between antioxidants and a reduced cancer risk. AICR has funded dozens of these studies. Some results have shown:

- Vitamin C (in foods such as oranges and broccoli) may help reduce the risk of

- stomach cancer.
- Vitamin E (in foods such as almonds and whole wheat) may help lower the incidence of cancers of the prostate and colon.

- The mineral selenium (in mushrooms and whole grains) may reduce risk for prostate and lung cancers.
- Resveratrol, a phytochemical in red grapes, may inhibit growth of colon and other tumors, and help to repair gene mutations.
- Whole grains contain a number of antioxidants that may help to protect the colon, where they become activated during the digestive process.

Researchers are becoming more convinced that cancer protection does not come from any single antioxidant. Dr. Ritva Butrum, Senior Science Advisor to AICR, says, “We seem to be past the stage of hoping that super high doses of any one substance can be a ‘magic bullet’ against cancer or other health problems.”

It will take more studies with human subjects to draw any firm conclusions about specific antioxidants. But currently there is strong enough evidence to draw a general conclusion. People who eat a mostly plant-based diet that contains plenty of fruits, vegetables, whole grains, beans and moderate amounts of nuts have lower cancer risk.

Some exciting research results show that within a few weeks of adding more fruits and vegetables to their diets, people who do not smoke have increased blood levels of antioxidants and decreased oxidative damage. This study also showed that one group that took supplements showed a reduction in oxidation damage, but still had more damage than the group that ate antioxidant-rich foods. An earlier study showed similar results.

Researchers have developed a test called “oxygen radical absorbance capacity” (ORAC) to determine the antioxidant capacity in specific vegetables, fruits and herbs. This test tube analysis measures the ORAC value in human blood. A higher score means greater effectiveness. Some results from ORAC studies so far are:

Food Item	Serving Size	ORAC Score
Pinto bean	½ cup	11,864
Blueberry	1 cup	9,019
Cranberry	1 cup	8,983
Prune	½ cup	7,291
Strawberry	1 cup	5,938
Red Delicious apple	1 whole	5,900

Other foods that showed high activity are kale, spinach, Brussels sprouts, broccoli, plums, oranges, red bell pepper and kiwi fruit, according to the USDA.

Why different foods appear to have more antioxidant capacity is not yet known, and may result from factors such as their genetic compositions. But the important thing to remember is that eating plenty and a wide variety of vegetables and fruits is the surest way to get the most antioxidant protection.



Future Directions for Antioxidant Research



Antioxidant researchers need to conduct more studies on how different antioxidants work in combination to affect cancer risk. It is known that these compounds interact with each other, influencing how effectively they are absorbed in the body.

In one recent study, rats fed a combination of tomato and broccoli powders made from whole vegetables showed significantly less prostate tumor growth than other groups of rats in the study that were fed tomato powder alone, broccoli powder alone, or only a diet supplemented with the isolated phytochemical lycopene.

In fact, an increasing number of studies are showing that thousands of substances in plant foods seem to interact in complex ways. When some antioxidants are eaten together, some seem to reinforce – and, in some cases, multiply – each other's cancer fighting potential.

Scientists are now looking into how cooking and processing foods can increase or decrease the activity of some antioxidants. Lycopene, for example, is absorbed more easily by the body when it is eaten in the form of processed tomato sauce and other products, rather than in the form of raw tomatoes.

Immune response also may be boosted by antioxidants, as some research suggests, which could help to promote health in many ways. Different antioxidants may be more effective than

others against particular forms of cancer.

The very new field of research called “nutrigenomics” may actually someday be able to link an individual's genetic makeup with specific dietary substances, including antioxidants, to possibly help that person avoid diseases like cancer. Researchers funded by AICR are working on finding answers like these.

Today's Message: Rely on Whole Foods

Researchers are beginning to understand how antioxidants work and can best be used. But experts at AICR believe that a diet rich in citrus, tomatoes, peppers, berries, grapes, broccoli, cabbage, greens, like spinach and other vegetables, and fruits should provide all the antioxidants we need for good health and lower cancer risk.

For lower cancer risk, the American Institute for Cancer Research recommends filling $\frac{2}{3}$ or more of your plate with plant-based foods like vegetables, fruits, whole grains and beans and $\frac{1}{3}$ or less with animal proteins such as lean meat or dairy foods.

“The best advice is to cut down on animal products, particularly red meat, and substitute more brightly colored vegetables and fruits along with whole grains and beans,” says Dr. Butrum. “So many health protectors are found in these foods that scientists believe eating a large variety every day will reduce cancer risk to a measurable degree. In fact, combining a healthy diet with increased physical activity and a healthy weight can reduce the number of cancer cases by one-third.”

This brochure is informed by the AICR/WCRF Second Expert Report, Food, Nutrition, Physical Activity, and the Prevention of Cancer: a Global Perspective. The report, produced by WCRF/AICR, is the largest study of its kind ever published and its recommendations are based on the most comprehensive review of all the available evidence. The recommendations can be grouped into three guidelines:

AICR Guidelines for Cancer Prevention



The choices you make about food, physical activity and weight management can reduce your chances of developing cancer.

- Choose mostly plant foods, limit red meat and avoid processed meat.
- Be physically active every day in any way for 30 minutes or more.
- Aim to be a healthy weight throughout life.

*And always remember –
do not smoke or chew tobacco.*

The American Institute for Cancer Research (AICR) has taken a leadership role in supporting research in the area of phytochemicals, nutrition and cancer. Following is a partial list of recent grants awarded by AICR in this area.

EB 1089/Vitamin D3 and Radiation in Breast Tumor Cells

David A. Gewirtz, Ph.D.
Virginia Commonwealth University

Prevention of Metastatic Breast Cancer Using a Novel Vitamin E Analog

Emmanuel Akporiaye, Ph.D.
University of Arizona

Breast Cancer and NOS Suppression by Quercetin

Steven J. T. Jackson, Ph.D.
Medical College of Georgia

Plant Antioxidant Silibinin and Vitamin D in Therapy of Myeloid

Leukemia: Preclinical Studies

George P. Studzinski, M.D., Ph.D.
UMDNJ-New Jersey Medical School

Effect of Dietary Antioxidants on Genetic Instability and Cancer Incidence in Ataxia Telangiectasia

Robert H. Schiestl, Ph.D.
University of California at Los Angeles



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A Closer Look at Nutrigenomics

Guidelines for Cancer Prevention

Recommendations for Cancer Prevention

Eating Smart for Cancer Prevention

Call the Toll-Free Nutrition Hotline

Dial 1-800-843-8114 to leave a message for a registered dietitian (who will return your call), Monday-Friday, 9 a.m.-5 p.m. Eastern Time. Or visit the AICR Hotline on-line at www.aicr.org.

The American Institute for Cancer Research (AICR) is the cancer charity that fosters research on the relationship of nutrition, physical activity and weight management to cancer risk, interprets the scientific literature and educates the public about the results. It has contributed more than \$85 million for innovative research conducted at universities, hospitals and research centers across the country. AICR has published two landmark reports that interpret the accumulated research in the field and is committed to a process of continuous review. AICR also provides a wide range of educational programs to help millions of Americans learn to make dietary changes for lower cancer risk. Its award-winning New American Plate program is presented in brochures, seminars and on its Web site, www.aicr.org. AICR is part of the World Cancer Research Fund global network.

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