

# Compound in broccoli could boost immune system, says new study

**A compound found in broccoli and related vegetables may have more health-boosting tricks up its sleeves, according to a new study led by researchers at the University of California, Berkeley.**

Veggie fans can already point to some cancer-fighting properties of 3,3'-diindolylmethane (DIM), a chemical produced from the compound indole-3-carbinol when Brassica vegetables such as broccoli, cabbage and kale are chewed and digested. Animal studies have shown that DIM can actually stop the growth of certain cancer cells.

This new study in mice, published online today (Monday, Aug. 20) in the *Journal of Nutritional Biochemistry*, shows that DIM may help boost the immune system as well.

"We provide clear evidence that DIM is effective in augmenting the immune response for the mice in the study, and we know that the immune system is important in defending the body against infections of many kinds and cancer," said Leonard Bjeldanes, UC Berkeley professor of toxicology and principal investigator of the study. "This finding bodes well for DIM as a protective agent against major human maladies."

Previous studies led by Bjeldanes and Gary Firestone, UC Berkeley professor of molecular and cell biology, have shown that DIM halts the division of breast cancer cells and inhibits testosterone, the male hormone needed for growth of prostate cancer cells.

In the new study, the researchers found increased blood levels of cytokines, proteins which help regulate the cells of the immune system, in mice that had been fed solutions containing doses of DIM at a concentration of 30 milligrams per kilogram. Specifically, DIM led to a jump in levels of four types of cytokines: interleukin 6, granulocyte colony-stimulating factor, interleukin 12 and interferon-gamma.

"As far as we know, this is the first report to show an immune stimulating effect for DIM," said study lead author Ling Xue, who was a Ph.D. student in Bjeldanes' lab at the time of the study and is now a post-doctoral researcher in molecular and cell biology at UC Berkeley.

In cell cultures, the researchers also found that, compared with a control sample, a 10 micromolar dose of DIM doubled the number of white blood cells, or lymphocytes, which help the body fight infections by killing or engulfing pathogens. (A large plateful of broccoli can yield a 5-10 micromolar dose of DIM.)

When DIM was combined with other agents known to induce the proliferation of lymphocytes, the effects were even greater than any one agent acting alone, with a three- to sixfold increase in the number of white blood cells in the culture.

"It is well-known that the immune system can seek out and destroy tumor cells, and even prevent tumor growth," said Xue. "An important type of T cell, called a T killer cell, can directly kill certain tumor cells, virally infected cells and sometimes parasites. This study provides strong evidence that could help explain how DIM blocks tumor growth in animals."

DIM was also able to induce higher levels of reactive oxygen species (ROS), substances which must be released by macrophages in order to kill some types of bacteria as well as tumor cells. The induction of ROS - three times that of a control culture - after DIM was added to the cell culture signaled the activation of macrophages, the researchers said.

"The effects of DIM were transient, with cytokine and lymphocyte levels going up and then down, which is

what you'd expect with an immune response," said Bjeldanes. "Interestingly, to obtain the effects on the immune response, DIM must be given orally, not injected. It could be that the metabolism of the compound changes when it is injected instead of eaten."

To examine the anti-viral properties of DIM, the researchers infected mice with reoviruses, which live in the intestines but are not life-threatening. Mice that had been given oral doses of DIM were significantly more efficient in clearing the virus from their gut - as measured by the level of viruses excreted in their feces - than mice that had not been fed DIM.

"This means that DIM is augmenting the body's ability to defend itself by inhibiting the proliferation of the virus," said Bjeldanes. "Future studies will determine whether DIM has similar effects on pathogenic viruses and bacteria, including those that cause diarrhea."

The discovery of DIM's effects on the immune system helps bolster its reputation as a formidable cancer-fighter, the researchers said. "This study shows that there is a whole new universe of cancer regulation related to DIM," said Firestone, who also co-authored the new study. "There are virtually no other agents known that can both directly shut down the growth of cancer cells and enhance the function of the immune system at the same time."

Source: University of California - Berkeley

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