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The primary family of flavonoids contributing to the antioxidant benefit in chocolate is the procyanidins. Of the various types of procyanidins, pentamer seem to be strongest, according to a number of studies.

## Stopped Breast-Cancer Cell Division

The Georgetown researchers looked at what happened when they used a purified preparation of pentamer on a variety of breast-cancer cells, compared to treatment on normal breast cells. They used a variety of tests to find and identify proteins that were deactivated in the cancer cells.

What they located were two well-known tumor suppressor genes, as well as two other proteins known to be involved in regulating the "cell cycle" -- the progression of a cell from a state of being "quiet" into division and growth.

They specifically found that the breast-cancer cells stopped dividing when treated with pentamer and that all four proteins were inactivated. Furthermore, expression of one of the genes was reduced.

## Master Switch Turned Off?

Dickson notes that "the novel aspect here is that a pattern of several regulatory proteins are jointly deactivated, probably greatly enhancing the inhibitory effect compared to targeting any one of the proteins singly. That is also why the compound seems to work on cancer cells, irrespective of whether any of these single genes are mutated, which often happens in cancer cells."

The researchers don't know why pentamer deactivates these proteins simultaneously, stopping the cell cycle, he adds. "We don't know at a fundamental level whether a master switch that triggers cell growth is

turned off or whether the chocolate compound exerts multiple independent effects on diverse cellular processes. That will be the subject of future studies here."

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