

VITAMINS / SUPPLEMENTS

## Vitamin E Succinate Continues to Show Impressive Anti-Cancer Properties

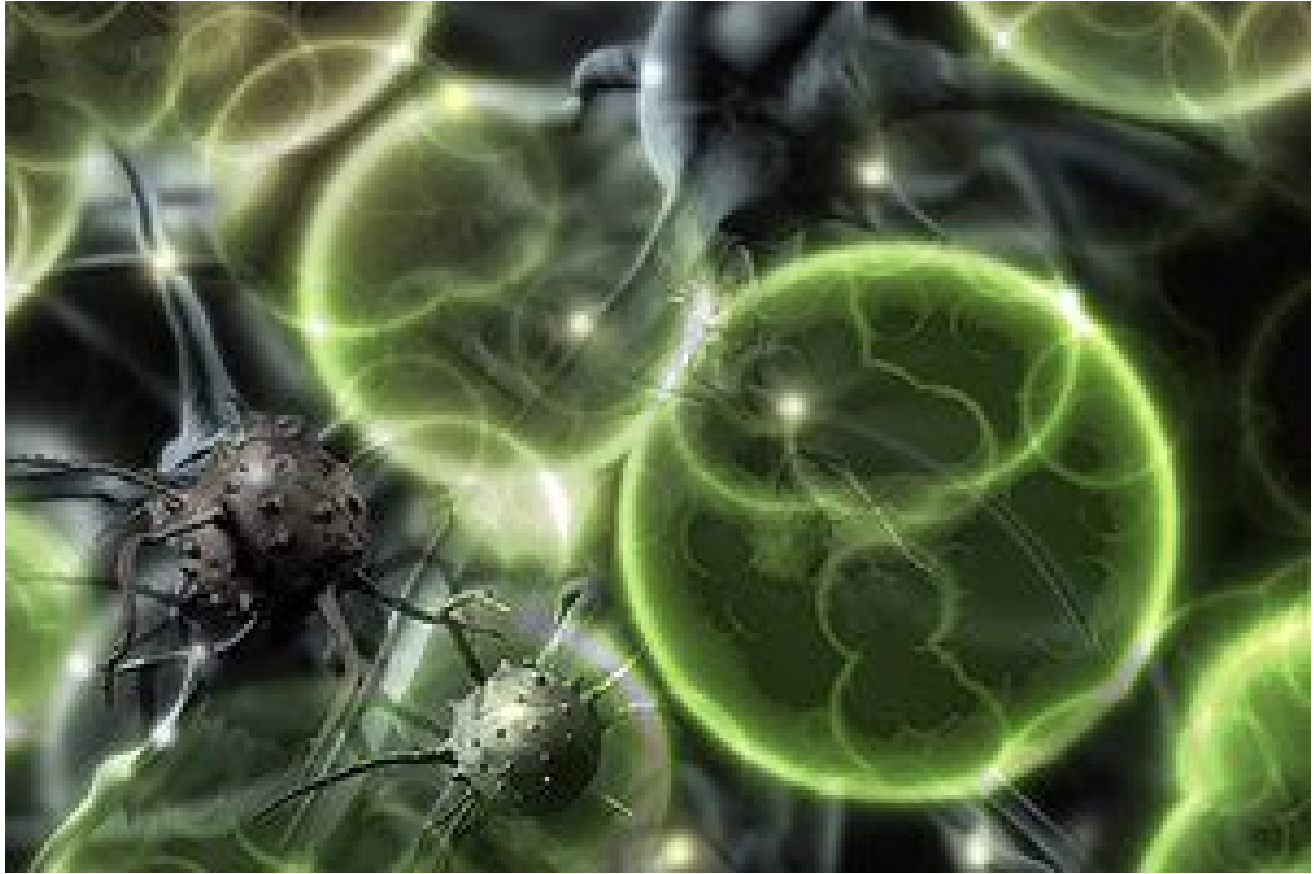
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Several recent short-term intervention studies failed to show vitamin E supplementation was protective against the development of various cancers, most notably lung and prostate cancer. In fact, in the SELECT study, individuals taking vitamin E supplements showed a 17 percent higher incidence of prostate cancer. But is that the end of the story? A review of the literature suggests while the recent research on vitamin E may be conflicting, evidence supporting the anti-cancer properties of a specific form of vitamin E known as *vitamin E succinate* (alpha-tocopheryl succinate) is promising.

### Vitamin E and Cancer: Controversy and Confusion

In the [SELECT study](#), researchers used a synthetic form of vitamin E known as dl-alpha tocopherol acetate. Some experts have argued this form of vitamin E has only half the potency of natural forms of vitamin E, and thus was a poor candidate for use in this and other trials. Others argue synthetic vitamin E competes with natural vitamin E (both tocopherols and tocotrienols) for receptor binding sites and other processes, reducing the cell's vitamin E antioxidant defenses and/or reducing other anti-cancer effects afforded by natural vitamin E (d-alpha-tocopherol).<sup>1-10,19</sup>

Still others have implied vitamin E succinate should be the form of vitamin E used in intervention trials aimed at reducing cancer incidence, as it is the form of vitamin E with the strongest current research support as an anti-cancer agent.<sup>20</sup>



Adding to the confusion are recent studies that suggest antioxidant supplementation actually may provide existing cancer cells with a survival advantage and thus facilitate the growth of cancer once cancer cells have been initiated. In this respect, it may be that antioxidant supplements *reduce* free-radical build-up in cancer cells, which prevents the induction of programmed cell death (apoptosis)<sup>1-10,19</sup>

Conversely, some long-term epidemiological studies suggest higher blood levels of vitamin E and the use of high-dose vitamin E supplements are associated with a decreased risk of many types of cancer, including lung and prostate cancer.<sup>11-12</sup>

One explanation for this conflicting data may be that high-dose vitamin E supplements (above 200 IU per day) may act as antioxidants to reduce DNA oxidation and mutations that lead to cancer, support immune cells responsible for killing emerging cancer cells, and possibly exert other anticancer epigenetic and genetic effects. However, in cancer cells that have *already been formed* (initiated), vitamin E may aid in their survival by providing them with antioxidant defenses they tend to lack.

It is established that cancer cells subjected to excess free-radical exposure undergo programmed cell death (apoptosis). Thus, it may be that taking natural vitamin E helps to prevent cancer development (initiation), but vitamin E also may promote cancer progression in cancer cells that have already been initiated (indolent cancer or latent cancers). More studies are required to fully understand the impact of d-alpha tocopherol (natural vitamin E) and dl-alpha tocopherol (synthetic vitamin E) on cancer prevention, development and potential use in adjunctive cancer treatment.<sup>13-14</sup>

## Vitamin E Succinate: Potent and Consistent Anti-Cancer Properties

Over a number of years, vitamin E succinate (alpha-tocopheryl succinate) has shown the most impressive anti-cancer properties compared to all other forms of vitamin E, including the [tocotrienols](#). Experimental studies continue to suggest only this form of vitamin E causes rapid production of reactive oxygen species (free radicals) selectively within cancer cells, triggering cell death, while being nontoxic to normal, healthy cells.

Vitamin E succinate also inhibits the anti-apoptotic function of Bcl-2 and Bcl-xl, normally expressed by tumor cells. Malignant cells typically try to block signals that lead to programmed cell death. One of the clever ways they do this is by blocking an important apoptotic signaling pathway controlled by the p53 tumor suppressor gene. Normally, an emerging cancer cell is detected by a network of internal surveillance genes (tumor suppressor genes), which in turn responds by upregulating the synthesis of the Bax protein. The Bax protein translocates to the mitochondria and exerts effects that lead to mitochondrial disruption and fragmentation. This prevents cancer cells from generating vital ATP energy, which in turn, triggers apoptosis (cell death).

Synthesis of the Bax protein is under control of the p53 tumor suppressor gene. However, malignant cells block the apoptotic effects of Bax protein by synthesizing the Bcl-2 protein. This inhibits the effects of the Bax protein, thereby enabling cancer cells to survive and thrive, even though tumor suppressor genes are sending signals directed at programmed cell death.

Vitamin E succinate is one of only a few compounds ever shown to inhibit the anti-apoptotic function of Bcl-2 and Bcl-xl (by blocking their BH3 domains). This also may explain, to some extent, how vitamin E succinate has been shown to sensitize cancer cells to other anti-cancer drugs, thereby improving their chemotherapy-killing effects.<sup>14</sup>

### Cancer Cells Are Highly Susceptible to Free Radicals

The emerging studies suggest cancer cells that are able to protect themselves against reactive oxygen species (free radicals) are less likely to undergo apoptosis (death). Thus, some experimental studies show antioxidant fortification via superoxide dismutase, N-acetylcysteine, coenzyme Q<sub>10</sub> and possibly other forms of vitamin E actually may provide cancer cells with a *survival advantage* due to their antioxidant properties.

However, vitamin E succinate appears to exert the opposite effect - it increases the accumulation of free radicals within cancer cells, which leads to cancer cell death. This has been shown to occur via vitamin E succinate's unique capacity to bind to complex II within the mitochondria, thus preventing binding of coenzyme Q<sub>10</sub> at this point in the mitochondrial chain. As such, coenzyme Q<sub>10</sub> becomes unable to transfer electrons to complex II, and thereby releases them within the cell. The unpaired electrons interact with cellular oxygen to form various reactive oxygen species, such as the superoxide anion (free radicals), which accumulate and trigger programmed cell death.

This mitochondrial disruption killing-effect of cancer cells has recently been demonstrated in a mouse model of breast cancer, in which many tumors showed overexpression of the [Her-2 receptor](#). The positive Her-2 receptor breast cancer phenotype is known to be highly aggressive and a stubborn form of cancer to kill.

Anti-cancer agents that target mitochondria disruption, leading to programmed cell death, are termed *mitocans*, which represent a new investigative and promising area of oncology research. Vitamin E succinate is one of the most promising mitocans discovered to date.<sup>14-15</sup> In addition, vitamin E succinate has shown other multimodal anticancer properties that have been reviewed by several researchers over the years.<sup>16-17</sup>

### Human Studies Underway

The impressive experimental cancer-killing effects of vitamin E succinate, coupled with our understanding of its observed anti-cancer properties (particularly reactive oxygen species-induced apoptosis, and inhibiting the anti-apoptotic effects of Bcl-2 and Bcl-xl), prompted researchers to test vitamin E succinate in a recent human case of mesothelioma. Malignant mesothelioma is a form of lung cancer caused by exposure to asbestos, and is highly resistant to radiation and chemotherapy.

In this single case study administering vitamin E succinate to a patient with malignant mesothelioma, the researchers stated, "The data revealed a significant clinical benefit with vitamin E succinate therapy, causing a reduction in tumor volume and improved the well-being of our subject, who had a lethal type of neoplastic pathology."

This outcome was published in *Lancet* in 2005, and the same researchers are currently preparing to conduct a larger clinical trial in which a cohort of mesothelioma patients will be treated with vitamin E succinate.<sup>14</sup> Experimental studies in the past have demonstrated the efficacy of vitamin E succinate in killing human malignant mesothelioma cells *in vitro*.<sup>15-16</sup>

### My Viewpoint

Due to the conflicting data surrounding the influence of vitamin E on cancer, it may be wise to choose a multivitamin that contains vitamin E in the form of vitamin E succinate at a minimum dose of 400 IU for purposes of health promotion and possibly cancer prevention.

Note that human oral supplementation studies using significant (supraphysiological) doses of vitamin E succinate have been shown to raise plasma levels of vitamin E succinate, but this is unlikely to occur with low-dose intake, as the pancreatic digestive esterase enzymes typically deconjugate the succinate moiety from vitamin E succinate in the gut.

In supraphysiological supplementation, a significant percentage of vitamin E succinate has been shown to get absorbed into the bloodstream intact, bypassing deconjugation by esterase enzymes in the gut. This is important because research suggests vitamin E succinate must reach cancer cells intact in order to exert its anti-cancer properties.<sup>17</sup>

It is noteworthy that vitamin E succinate does not possess antioxidant properties; however, some vitamin E succinate is deconjugated by pancreatic digestive enzymes (esterases) and the tocopheryl moiety is available for conversion to d-alpha-tocopherol. This is the natural form of vitamin E that does possess antioxidant properties.

The next step is for researchers to begin using vitamin E succinate more aggressively in animal models of cancer prevention and treatment to determine its efficacy and best route of administration. From

there, hopefully we will see its adoption in a greater number of human cancer trials in both prevention and adjunctive cancer treatment.<sup>20</sup>

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