



The Role of Resveratrol and Its Mechanism in Preventing Rectal Cancer

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Description

Resveratrol, a naturally occurring polyphenolic compound found in various plants, particularly in the skins of red grapes, berries, and peanuts, has gained substantial attention in recent years for its potential health benefits. Among these benefits, its role in cancer prevention, particularly rectal cancer, has been a focal point of scientific research.

Risk factors of rectal cancer

Rectal cancer, a type of colorectal cancer, originates in the rectum, the last few inches of the large intestine. It is a significant health concern worldwide, with high morbidity and mortality rates. Risk factors include age, family history, inflammatory bowel disease, diet, lifestyle, and genetic mutations. Conventional treatments include surgery, chemotherapy, and radiation therapy, which can have considerable side effects. Thus, the investigation of preventive measures, including dietary components like resveratrol, is important.

Resveratrol

Resveratrol (3,5,4'-trihydroxy-trans-stilbene) is a phytoalexin produced by plants in response to stress or pathogen attack. It has been studied extensively for its antioxidant, anti-inflammatory, and anticancer properties. The compound exists in two isomeric forms: Cis- and trans-resveratrol, with the trans form being more stable and biologically active.

Mechanisms of action in preventing rectal cancer

Antioxidant activity: Resveratrol is a potent antioxidant, neutralizing free radicals and reducing oxidative stress, which can cause DNA damage and contribute to cancer development. By mitigating oxidative damage, resveratrol helps maintain cellular integrity and prevents mutations that could lead to rectal cancer.

Anti-inflammatory effects: Chronic inflammation

is a known risk factor for cancer. Resveratrol inhibits the activity of inflammatory enzymes such as Cyclooxygenase (COX) and Lipoxygenase (LOX) and downregulates the expression of pro-inflammatory cytokines like TNF- α , IL-6, and IL-1 β . This anti-inflammatory action reduces the chronic inflammation that can promote cancerous changes in rectal tissue.

Regulation of cell cycle and apoptosis: Resveratrol influences cell cycle regulation and promotes apoptosis (programmed cell death) in cancer cells. It upregulates pro-apoptotic proteins like bax and downregulates anti-apoptotic proteins such as *Bcl-2*. Moreover, resveratrol can cause cell cycle arrest at various phases (G1, S, and G2/M) by modulating cyclins and Cyclin-Dependent Kinases (CDKs), thereby inhibiting the proliferation of cancer cells.

Inhibition of angiogenesis: Angiogenesis, the formation of new blood vessels, is important for tumor growth and metastasis. Resveratrol inhibits angiogenesis by downregulating Vascular Endothelial Growth Factor (VEGF) and other angiogenic factors. This inhibition restricts the blood supply to tumors, limiting their growth and spread.

Epigenetic modulation: Resveratrol has been shown to modify the expression of genes involved in cancer through epigenetic mechanisms, such as DNA methylation and histone modification. By altering the epigenetic landscape, resveratrol can turn off oncogenes and activate tumor suppressor genes, contributing to its anticancer effects.

Modulation of signaling pathways: Resveratrol affects several signaling pathways implicated in cancer development, including the Wnt/ β -catenin, PI3K/Akt, and MAPK pathways. By modulating these pathways, resveratrol can inhibit cancer cell proliferation, induce apoptosis, and reduce metastatic potential.

Clinical evidence and future directions

Preclinical studies have provided substantial evidence supporting resveratrol's anticancer effects. In animal models, resveratrol has demonstrated the ability to prevent and slow the progression of colorectal cancer. However, clinical trials in humans have yielded mixed results, primarily due to issues with bioavailability and metabolism. Resveratrol is rapidly metabolized and eliminated, which limits its efficacy. To overcome these challenges, researchers are investigating various strategies, including the use of resveratrol analogs,

combination therapies, and novel delivery systems such as nanoparticles and liposomes, to enhance its bioavailability and therapeutic potential. Resveratrol presents a potential natural compound for the prevention and treatment of rectal cancer through its multifaceted mechanisms of action. While preclinical studies are promising, more research is needed to translate these findings into effective clinical applications. As our understanding of resveratrol's molecular mechanisms deepens, it holds potential as part of an integrated approach to cancer prevention and therapy.