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THE ROLE OF CHLOROPHYLL IN CANCER TREATMENT: CONTEMPORARY INSIGHTS AND CLINICAL PROSPECTS

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Cancer continues to pose a major global public health challenge, remaining among the primary causes of disease-related mortality and morbidity worldwide. Data reported by the World Health Organization indicate that cancer was responsible for nearly 10 million deaths globally in 2022, with incidence rates showing a steady upward trend, particularly in low- and middle-income regions (World Health Organization [WHO], 2023). Although considerable progress has been achieved in conventional cancer therapies—including surgery, chemotherapy, radiotherapy, and molecularly targeted treatments—these approaches are often limited by adverse effects, therapeutic resistance, and diminished patient quality of life. Consequently, increasing scientific attention has been directed toward natural bioactive substances as complementary strategies in cancer prevention and treatment.

Among various naturally occurring compounds, chlorophyll and its derivatives have emerged as promising candidates due to their diverse biological activities and potential anticancer effects. Chlorophyll is a green photosynthetic pigment widely distributed in plant-based foods such as spinach, broccoli, and parsley. From a structural standpoint, chlorophyll closely resembles hemoglobin, with the primary distinction being the central metal ion—magnesium in chlorophyll and iron in hemoglobin. This molecular similarity has prompted extensive investigation into its physiological relevance and possible role in modulating pathological processes, including carcinogenesis.

Experimental and preclinical research suggests that chlorophyll and its semi-synthetic derivative, chlorophyllin, exert anticarcinogenic effects through multiple mechanisms. One of the most extensively studied actions is their capacity to bind carcinogenic substances. Chlorophyllin has demonstrated a strong affinity for mutagenic compounds such as aflatoxins, heterocyclic amines, and polycyclic aromatic hydrocarbons, forming stable complexes that limit their absorption within the gastrointestinal tract. Notably, a human intervention study conducted in China reported a significant reduction— approximately 55%—in aflatoxin–DNA adduct formation among individuals receiving chlorophyllin supplementation, highlighting its potential role in lowering biomarkers associated with cancer risk.

Beyond its detoxifying properties, chlorophyll exhibits notable antioxidant activity. Oxidative stress, largely driven by excessive production of reactive oxygen species (ROS),

plays a critical role in DNA damage, genomic instability, and tumor initiation. Chlorophyll has been shown to neutralize free radicals and enhance the activity of endogenous antioxidant enzymes, thereby mitigating oxidative damage and supporting cellular integrity.

Emerging evidence further indicates that chlorophyll-based compounds may influence cancer cell growth and survival. In vitro investigations have demonstrated that chlorophyllin can suppress proliferation and induce apoptosis in several cancer cell lines, including those derived from colorectal, hepatic, and breast malignancies. These effects are thought to involve mitochondrial dysfunction, regulation of apoptosis-related genes, and activation of intrinsic cell death pathways. While these findings remain largely confined to laboratory models, they provide a compelling rationale for further translational research.

From a clinical standpoint, chlorophyll is generally regarded as safe and well tolerated, with few reported adverse effects. This favorable safety profile enhances its potential utility as a supportive agent in oncology, particularly for alleviating treatment-related toxicity and improving overall patient well-being. Nevertheless, despite promising experimental and early clinical outcomes, robust evidence from large-scale randomized controlled trials remains limited.

In summary, chlorophyll represents a biologically active natural compound with considerable promise in cancer prevention and adjunctive therapy. Its ability to modulate carcinogen bioavailability, reduce oxidative stress, and promote apoptosis underscores its potential supportive role alongside conventional cancer treatments. Future clinical investigations are required to clarify optimal dosing strategies, therapeutic efficacy, and long-term safety. The integration of chlorophyll-based interventions into evidence-based oncology may ultimately contribute to more comprehensive and patient-centered cancer management approaches.

World Health Organization. (2023). *Cancer fact sheet*. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/cancer