**Preventative research and utilization of phytochemical compounds in cancer.**

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**Even with targeted chemotherapy and immunotherapy advancements, some cancers have yet to see any significant improvement in complete remission or even mortality rate. Along with the vast demand for better cancer treatments, alternative therapies are also heavily needed due to the cytotoxic nature of most treatments. Phytochemicals have shown encouraging anticarcinogenic and proapoptotic properties that spurred many researchers to identify and test the potentiality of phytochemical inclusion in chemotherapy. Recent progress in the field of phytochemical research has identified naturally derived chemical compounds that have the potential to inhibit the growth and maturation of cancer cells in human subjects. There have also been advancements in extraction methodologies that can better yield the bioactive components within phytochemical plants. Despite these recent advancements, there are still significant gaps in the realm of phytochemical usage in cancer therapies and the reduction of cancer mortality. Nonetheless, much progress has occurred in cancer research, and these potential leads in phytochemical utilization in cancer treatments may finally improve specific cancer prognosis.**

**Introduction**

Phytochemicals derived from plant extracts have become essential sources for a lot of pharmaceutical treatments. Chemical compounds found in phytochemicals have been the target of research looking into alternative therapies for cancer. Phytochemical compounds can work in several ways to inhibit proliferation, promote proapoptotic factors, and disrupt cell cycles through cytotoxic properties. In helping to disrupt or stop essential protein pathways in cancer cells, phytochemicals can aid in the treatment of certain cancers without overly taxing or destroying the body’s healthy cells. Homeopathic remedies have always existed in our histories and cultures, teaching us how to heal ourselves with the bio flora around us. Despite significant advancements in medicine, research into natural remedies can provide vital insights into today’s current health epidemics. Many times, cancer treatment causes more damage to a patient’s healthy tissues than cancer itself. It is more important than ever to explore natural bioactive compounds for alternative treatment options.

**Recent Progress**

Finding novel cancer treatments is imperative, as many often-used treatments today show little to no effect in remission in some of the most aggressive forms of cancer. Side effects of such medicines also cause significant concern due to the cytotoxic nature of cancer treatment. Recent studies have found promising new avenues of research regarding the proapoptotic, antiproliferation, and bioactive potential of different phytochemical compounds (Frauches et al., 2021). A study conducted by Zhou et al. (2021) found that curcumin had more potent cytotoxic effects by protein regulation against three different types of phytochemicals. All four compounds tested in this study were chosen based on previous studies done against acute myeloid leukemia (AML), a hematological cancer that exhibits clonal expansion and differentiation arrest of myeloid progenitor cells (Zhou et al., 2021). AML maintains a high mortality rate, despite advances in chemotherapy. The mechanisms in which these phytochemicals affect various signaling pathways and enact antitumor effects are not clear. Six different AML cell lines were chosen to test cytotoxic activity with the addition of decitabine, which is a DNA-methyltransferase inhibitor that is FDA approved for treatment for AML (Zhou et al., 2021). After curcumin was found to have the most overall cytotoxic effect and the ML-2 cell line was shown to be the most sensitive to curcumin, mice inoculated with the ML-2 cell line were treated with varying doses of curcumin. Zhou et al. (2021) found that protein kinase B, which is often overactivated in AML, is the main target of curcumin, hence its anti-AML properties.

Malignant melanoma is the most aggressive form of skin cancer derived from melanocytes. Along with its high mortality rate, malignant melanoma is highly metastatic; thus, inhibiting cell growth has proven challenging. Depending on their molecular structure, natural products present different mechanisms against tumor cells (Marelli et al., 2021). Two Cachrys species were utilized in evaluating photocytotoxicity properties in melanoma cell treatment. A new extraction method was also tested against an already established method to ascertain if it gave a better yield of chemical components found in the plants. Marelli et al. (2021) observed that using the new method yielded a better chemical composition from the two plant species. As for the plant species, it showed promising potential for further testing as possible photochemotherapy agents against melanoma.

Frauches et al. (2021) aimed to compare the phytochemical and antioxidant abundance of three Brazilian native fruits in dried peel powders and freeze-dried extracts for their apoptotic and antiproliferative effects on colonic cancer cells. Research indicates that a diet rich in phytochemicals is associated with a reduced risk of developing colorectal cancer. Both extraction methods used in this study were compared to identify which provided the best yield of phytochemical compounds and antioxidants. Antioxidants are bioactive compounds that are produced in both animals and plants as a means to maintain homeostasis with free radical production. The balance of antioxidants and reactive free radicals is necessary to prevent the increased likelihood of cancer incidence. The phytochemical compound, anthocyanins, was found in high abundance in all three fruit peels, along with a high phenolic content profile (Frauches et al., 2021). The dried peel powders won as the better of the two extraction methods in terms of phytochemical content. Data from this study indicated a potential for further research to confirm the chemotherapeutic benefits of the three dried peel-powered extracts.

Similar trends of identifying means of the best extraction methods to result in better yield while also identifying the exact compounds responsible for the inhibition of cancer cell formation have been noted to occur in the realm of breast cancer research. Alkateeb et al. (2021) observed that aqueous extraction of purple basil blossoms at low temperatures had higher amounts of flavonoids and phenolic compounds than another aqueous extract that used boiled water solvents and alcoholic extracts. Apoptotic factors of the extracts were measured in MCF7 breast cancer cells. The low-temperature aqueous extract significantly reduced the development and growth of breast MCF7 cancer cells through apoptotic and oxidative stress intervention systems (Alkateeb et al., 2021). Flavonoids, a class of phytochemicals, suppress proliferation and participate in chemoprevention due to their highly active biocomponents.

**Discussions**

Recent progress in identifying potential chemotherapeutic phytochemical components may be the approach needed to discover a novel treatment for cancers whose prognoses have seen little to no improvement. By discovering chemotherapeutic phytochemical components, we can research potential alternative treatments that have significantly reduced side effects. Phytochemicals and the bioactive compounds that they are made of have been known for preventative benefits for cancer. Identifying extraction methods that result in better yields of the phytochemical profiles is desired as it can lead to better isolation of certain compounds known to have an active role in cancer prevention. It is also beneficial to the environment as there are fewer means of over-harvesting plants as a highly concentrated solution can be extracted with less than previously established methods. Exploring different genus and species of plants might thrust scientists into further identifying alternatives or combinations of therapies against cancer while also identifying the specific metabolic and signal pathways necessary to target cancer. A combination of current treatment therapies with phytochemical components might be another approach researchers can take in the future. Research into how these particular phytochemicals regulate apoptotic factors in cancer cells can also give critical insight into how better to target metabolic and protein pathways so that healthy cells can remain unscathed in treatment. In truth, while cancer is unpredictable, research into phytochemical anticarcinogenic benefits highlights the importance of diet and a healthy lifestyle. Eating a healthy variety of antioxidant and phytochemical-rich foods has shown significant benefits in reducing the risk of certain cancers; nutrition might also benefit in uncovering cancer cures. For now, it is a burgeoning new field, aided by new technologies and extraction methods, and shows a promising future in being able to understand perhaps a more natural derivative cure for cancer.

**References**

Alkhateeb, M.A., Al-Otaibi, W.R., AlGabbani, Q. et al. Low-temperature extracts of Purple blossoms of basil (Ocimum basilicum L.) intervened mitochondrial translocation contributes prompted apoptosis in human breast cancer cells. Biol Res 54, 2 (2021). https://doi.org/10.1186/s40659-020-00324-0.

Marrelli M, Perri MR, Amodeo V, Giordano F, Statti GA, Panno ML, Conforti F. Assessment of Photo-Induced Cytotoxic Activity of *Cachrys sicula* and *Cachrys libanotis* Enriched-Coumarin Extracts against Human Melanoma Cells. *Plants*. 2021;10(1):123.https://doi.org/10.3390/plants10010123

Simas Frauches N, Montenegro J, Amaral T, Abreu JP, Laiber G, Junior J, Borguini R, Santiago M, Pacheco S, Nakajima VM, Godoy R, Teodoro AJ. Antiproliferative Activity on Human Colon Adenocarcinoma Cells and In Vitro Antioxidant Effect of Anthocyanin-Rich Extracts from Peels of Species of the *Myrtaceae* Family. *Molecules*. 2021;26(3):564.https://doi.org/10.3390/molecules26030564

Zhou, H., Ning, Y., Zeng, G., Zhou, C., Ding, X."Curcumin promotes cell cycle arrest and apoptosis of acute myeloid leukemia cells by inactivating AKT". Oncology Reports 45.4 (2021): 11.