ISSN: 3139-3683

JOURNAL OF HEALTH SYNAPSE (JHS)

Peer Reviewed Refereed Open Access International Multidisciplinary Journal

Publisher: Scientistic Era Private Limited

Journal Hompage: https://healthsynapse.org

Turmeric: The Golden Shield of Nature that can Treat Cancers

Khushi Pandey[a], Mansi Negi[a,b*], Awijeet Tiwari[a], Sanjay Kumar Tiwari[c], Himani Sharma[d]

[a]*Department of Research and Development, Scientistic Era Pvt Ltd., Bahadurgarh, Haryana-124507, India*

[b]*All India Institute of Ayurveda (AIIA), Government of India, New Delhi - 110076, India s*

[c]*Department of Kayachikitsa, All India Institute of Ayurveda, Sarita Vihar, New Delhi, India*

[d]*Department of Shalakya Tantra, Sanjeevani Ayurveda Medical College, Amroha, Uttar Pradesh, India*

This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author(s) and the source are properly cited.

ARTICLE INFO

Keywords:
Turmeric,
Curcumin, Cancer prevention,
Anticancer mechanisms,
Antioxidant activity,
Bioavailability enhancement,
Complementary and integrative cancer therapy

ARTICLE HISTORY
Received Date: 5 January 2026
Revised Date: 15 January 2026
Accepted Date: 25 January 2026
Published Date: 30 January 2026

CITATION
Negi. M., 2026. Turmeric: The Golden Shield of Nature that can Treat Cancers. *Journal of Health Synapse (JHS), 1(1), 01-19. https://doi.org/10.67529/jhs.v1i1.1*

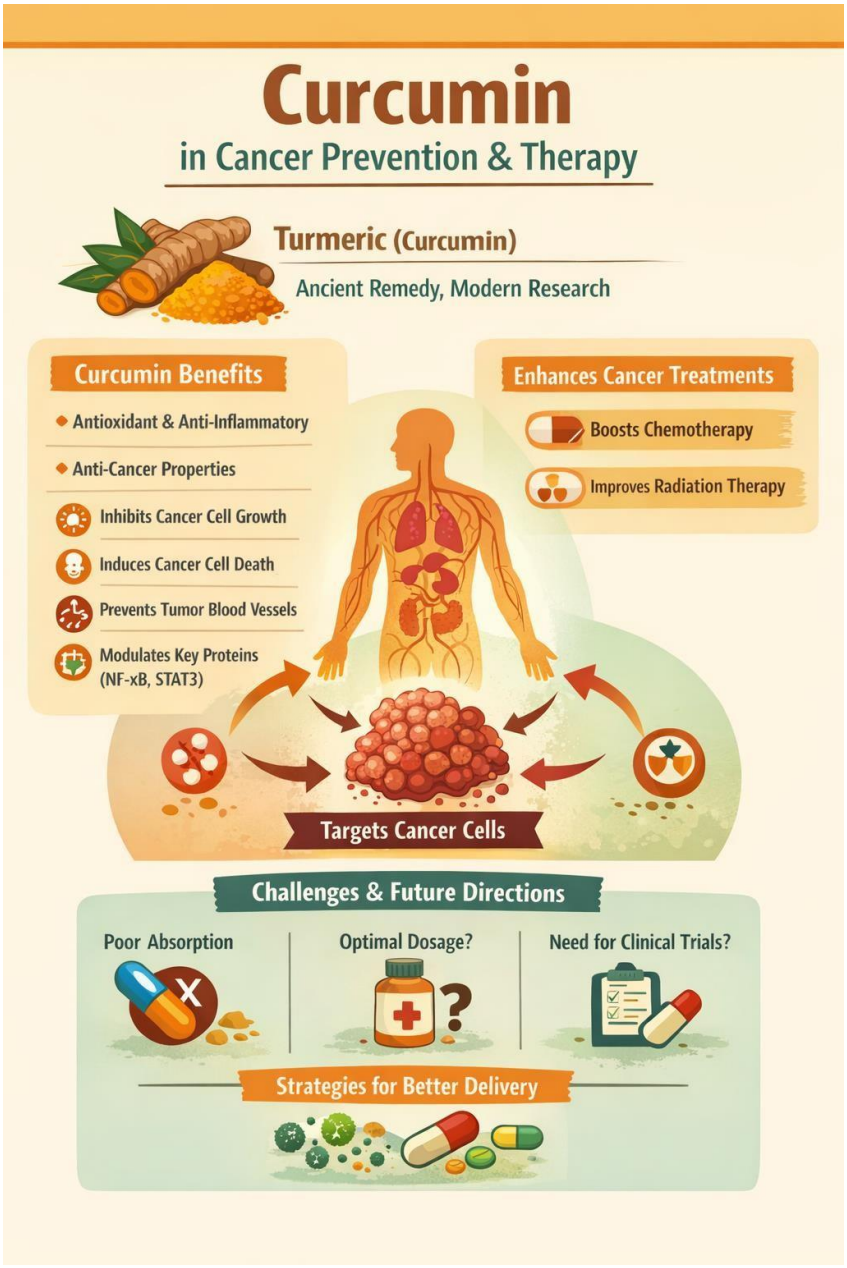
A B S T R A C T

The potential health advantages of turmeric, a golden-yellow root that has a long history of use in South Asian cuisine and traditional medicine, have attracted significant scientific interest. The main ingredient in turmeric, curcumin, has anti-inflammatory, anti-free radical, and maybe cancer-preventive effects. Based on studies conducted in labs, curcumin has the potential to impact various pathways that lead to cancer progression. These pathways include halting cell proliferation, killing cancer cells, stopping the formation of new blood vessels that supply tumors, and changing specific proteins that control gene function, like NF-κB and STAT3. Laboratory studies have shown that curcumin enhances the effectiveness and decreases the side effects of conventional cancer treatments, such as radiation and chemotherapy, suggesting that it could be utilized as an adjuvant treatment. Unfortunately, curcumin has a poor oral bioavailability, finding the optimal dosage is challenging, and there aren't enough large-scale trials to support its efficacy, making its application in actual medical contexts challenging. This study compiles recent research on curcumin and turmeric as they pertain to cancer treatment, discusses potential future applications, and suggests strategies to enhance their current use.

I. Introduction

Historical and Traditional Use

Turmeric is a member of the ginger family of plants (Curcuma longa L.). For almost two millennia, practitioners of Ayurveda and Traditional Chinese Medicine have relied on it. Turmeric is a bitter herb that is said to be warming and cleansing, according to ancient texts. Its traditional uses included cleansing the blood, aiding digestion, and increasing blood flow. In traditional South Asian medicine, turmeric was taken internally to alleviate gastrointestinal, respiratory, and stomach issues. They also used it topically as a paste to alleviate aches and pains in the joints, as well as to cure cuts and scrapes and skin diseases. Scientists became interested in the plant's compounds and health advantages after learning about its lengthy history of use [1-2].



The Turmeric Plant's Phytochemistry

A class of compounds known as curcuminoids are responsible for turmeric's primary medicinal benefits. Curcumin, bisdemethoxycurcumin, and demethoxycurcumin are all part of this class. Turmeric gets its characteristic yellow hue from curcumin, the most famous of its components. Roughly 3-5 percent of the dry root of the plant is composed of it. This may be a tiny quantity, but curcumin has a big impact on the body. Additional compounds contained in turmeric, in addition to curcuminoids, include proteins, carbs, lipids, and trace amounts of minerals. In certain cases, they may complement one another to improve health [3–4].

Action Mechanisms: Anti-Inflammatory and Antioxidant Benefits

New studies demonstrate that curcumin is an effective antioxidant and anti-inflammatory. By inhibiting specific proteins in the body, like NF-κB and AP-1, it aids in decreasing inflammation. As a result, enzymes like COX-2 and iNOS are reduced in activity, and damaging substances like TNF-α, IL-1β, and IL-6 are reduced in synthesis. Additionally, curcumin helps the body get rid of harmful molecules called reactive oxygen species (ROS) and reactive nitrogen species (RNS). It also helps the body's antioxidant enzymes—catalase, glutathione peroxidase, and superoxide dismutase—do their jobs better. These measures aid in lowering oxidative stress, which has been associated with DNA damage and cancer progression [5-8].

A Multi-Target Strategy for Curcumin in Cancer Treatment

Cancer is a complex disease characterized by uncontrolled cell proliferation, genetic instability, and disruptions in intracellular communication. According to recent research (Mantovani et al., 2008), one of the main causes of cancer is chronic inflammation and free radical damage. As a result of its effects on these pathways, curcumin influences numerous critical bodily functions:

- It induces cell death (apoptosis) and halts the proliferation of cancer cells.
The process of angiogenesis, the growth of new blood vessels that supply tumors, is halted.
According to Kunnumakkara et al. (2017), it aids in the regulation of both cancer-preventing genes (tumor suppressor genes) and cancer-causing pathways (PI3K/Akt, MAPK, and Wnt/β-catenin).
This has the potential to affect numerous targets concurrently, in contrast to drugs that merely target one component of the process.references 7, 8

Results from Clinical and Preclinical Research
Curcumin has shown promising anti-cancer properties in both animal and laboratory trials. These effects have been observed against a variety of malignancies, including those of the mouth, liver, breast, colon, pancreatic, prostate, and lung (Wilken et al., 2011). In addition to reducing cancer symptoms and other treatment-related side effects, preliminary clinical research suggests that curcumin is typically safe and well-tolerated (Lao et al., 2011). However, curcumin's poor absorption, rapid breakdown, and rapid elimination from the system severely limit its therapeutic utility (Anand et al., 2007). Researchers are looking into several delivery methods for curcumin, such as phospholipid complexes, nanoparticles, and liposomes (Prasad et al., 2014). They are also considering mixing curcumin with other chemicals, such as piperine, to increase its efficiency.2-4, 9-11

3. Review of Related Literature

(A) Past Studies
Curcumin, the primary active component of turmeric (Curcuma longa), has been demonstrated in numerous animal and laboratory studies to inhibit the development and progression of cancer in multiple ways.
A protein known as NF-κB, which plays a role in inflammation and cell viability, is blocked by curcumin. As a result, inflammatory proteins (such as IL-1, IL-6, and TNF-α) and damaging enzymes (such as COX-2) are reduced in synthesis (Aggarwal & Harikumar, 2009). A number of other mechanisms are involved, including the activation of caspases, an increase in anti-cancer proteins (such as p53), a decrease in cell-death proteins (such as Bcl-2), and an increase in cell-growth proteins (such as cyclin D1) (Goel et al., 2008).
Also, curcumin blocks proteins like VEFG, which stimulate blood vessel growth, so it prevents tumors from getting new blood vessels (Kunnumakkara et al., 2017). Curcumin has been shown in numerous animal and laboratory trials to inhibit tumor growth in a variety of malignancies, including breast, colon, prostate, pancreatic, and head and neck cancers (Shanmugam et al., 2015). This is likely due to its diverse actions.1, 8, 15,

(B) Present Studies
Clinical trials have progressed to the early stages as a result of these findings.
Taking curcuminoids (around 500 mg daily) reduced levels of inflammation markers like C-reactive protein and erythrocyte sedimentation rate, according to small trials conducted on colorectal cancer patients undergoing chemotherapy. This contributed to an overall betterment of their living conditions (Patel et al., 2020). A 61% disease control rate was observed in a phase II trial that combined gemcitabine chemotherapy with curcumin (in a phospholipid complex form) in patients with advanced pancreatic cancer. The treatment was well-tolerated, and patients lived an average of 10 months (Kanai et al., 2011).
There have also been trials using topical curcumin. Compared to a placebo, a 2% curcumin gel lessened the severity of radiation-induced skin responses in a randomized, double-blind study included 52 breast cancer patients undergoing irradiation (Ryan et al., 2013).

Curcumin may improve the efficacy of chemotherapy, according to studies on combination therapy.
In a study involving 150 women who had metastatic breast cancer, researchers found that administering intravenous curcumin in conjunction with paclitaxel therapy improved physical performance and patient-reported weariness more effectively than a placebo (Cheng et al., 2020). The response rate was also greater (51% vs. 33%). Prasad et al. (2014) reported that early clinical trials involving the combination of curcumin and medications such as docetaxel or gemcitabine shown an improvement in tumor markers along with a decrease in side effects. These preliminary findings provide credence to the theory that curcumin may enhance the efficacy of chemotherapy while mitigating some of its negative side effects. Still, more extensive trials involving several centers are required.referenced as [2,12,13,14]

4. Research Gap
Turmeric and its major ingredient curcumin have shown promise in a number of cancer trials, but the herb is still unable to be used routinely in medical practice due to a number of issues.
The fact that curcumin is poorly absorbed by the body is a major concern. Due to its rapid breakdown and elimination by the liver after consumption, insufficient amounts remain in the blood for effective action. The preparation and administration of curcumin are not standardized either. It is difficult to compare results and determine its efficacy because different research employ different amounts, methods of production, and delivery systems. On top of that, there are consistently methodological issues with curcumin research conducted on humans. It is difficult to draw strong conclusions from these studies because of their small sample sizes, lack of time to complete the tasks, and improper use of controls and double-blind testing. To address these concerns, researchers are exploring novel approaches, such as improving curcumin delivery through nanotechnology, combining it with other compounds that enhance its absorption, and employing standardized, high-quality extracts [2,4,9,11].

5. Research Objectives
The primary objective of this review is to examine and thoroughly verify the scientific data pertaining to curcumin, the primary active component of turmeric.

Curcumin has the potential to aid in cancer prevention and treatment, and we aim to learn more about it. Several interrelated objectives make up this review.
To start, we will review clinical and laboratory trials that have investigated the efficacy of curcumin in combating various cancers, including those of the breast, colon, prostate, pancreas, and blood.
Next, we will investigate the effects of curcumin on bodily cells and molecules, paying special attention to the ways it modifies crucial pathways such as NF-κB, STAT3, Wnt/β-catenin, and PI3K/Akt/mTOR. We will also examine the mechanisms by which curcumin inhibits cell proliferation, new blood vessel formation, and cancer cell death.
Another objective is to determine the transferability of laboratory results to clinical practice.
We will examine clinical trials involving humans to determine the safety of using curcumin in conjunction with conventional cancer treatments. One aspect of this is investigating its potential to improve the safety and efficacy of radiation and chemotherapy.
We will also examine the gaps and issues with the present curcumin research.
Problems with drawing firm results include issues with curcumin absorption, variations in its production and administration, and the heterogeneity of study methods. We will also examine new methods of delivering curcumin, such as its use in nanoparticles and liposomes, and its potential for enhanced efficacy through combination with other chemicals.
Last but not least, we will propose areas for future research, highlighting the importance of larger, more well-organized investigations as well as the necessity for transparent protocols to translate promising laboratory findings into practical clinical applications.

6. Research Methodology

Drawing mostly on previously published studies, this review piece takes a narrative and qualitative approach. Important discoveries regarding the cancer-fighting capabilities of turmeric and its primary ingredient, curcumin, were gathered and brought together after a comprehensive study of academic literature.
We searched through reports from clinical trials published between 2009 and 2024, as well as peer-reviewed scientific journals, laboratory studies (in both living and in vitro), systematic reviews, and meta-analyses.
The information was retrieved from various internet databases, including PubMed, ScienceDirect, SpringerLink, Scopus, and Google Scholar. To ensure that we covered all relevant research, we utilized search phrases such as "turmeric," "Curcuma longa," "curcumin," "anticancer," "chemopreventive," "clinical trials," and "molecular pathways." We also made use of Boolean operators like AND and OR.

7. Data Analysis

7.1 Mechanisms of Action

Antiproliferative Effects

Curcumin has a reputation for inhibiting the proliferation of cancer cells.
It achieves this by interfering with critical steps in the cell cycle. Enzymes known as cyclin-dependent kinases (CDKs) are inhibited and proteins like cyclin D1 have their activity reduced. Because of this, cell growth is inhibited during specific phases of the cell cycle, such as G1/S and G2/M. This method reduces tumor growth and stops cancer from spreading. This halt in cell proliferation makes cancer cell multiplication and metastasis more difficult, according to research (Wilken et al., 2011; Kunnumakkara et al., 2017).(8, 9).

Pro-apoptotic Activity

By inducing cell death, or apoptosis, curcumin can aid in the elimination of cancer cells.
It triggers the demise of cells through both internal and external mechanisms. Some of these processes include activating a cascade of events known as the caspase cascade, which in turn increases levels of reactive oxygen species (ROS), and damages the mitochondria, the cell's energy storage and production units. Cancer cells die as a result of all these alterations to their DNA. Curcumin is a safer therapy choice because it primarily targets cancer cells rather than healthy ones (Aggarwal & Harikumar, 2009; Gupta et al., 2013).1, 3

Anti-angiogenic Properties

New blood arteries supply nutrients that tumors require to grow.
One way curcumin halts this process is by decreasing synthesis of matrix metalloproteinases (MMP-2 and MMP-9), vascular endothelial growth factor (VEGF), and other proteins involved in blood vessel formation. According to Basu et al. (2013) and Kunnumakkara et al. (2017), curcumin inhibits tumor growth and metastasis via decreasing these proteins.(pages 8–9)

Immunomodulatory Effects

Tumors can grow with the help of new blood vessels, which carry nutrients.
Curcumin inhibits this process in part by reducing protein production of vascular endothelial growth factor (VEFG), matrix metalloproteinases (MMP-2 and MMP-9), and others that are involved in the development of blood vessels. Basu et al. (2013) and Kunnumakkara et al. (2017) state that curcumin reduces these proteins, which in turn prevent tumor growth and metastasis. (pages 8–9)

Epigenetic Regulation

According to recent research, curcumin can prevent cancer by influencing the body's gene regulation.
It modifies the activity of small RNA molecules, modifies the marking of DNA, and modifies the function of proteins in the cell nucleus. At a very modest level, these alterations can reverse genes that promote cancer and turn on genes that prevent cancer cells from proliferating, so halting the progression of cancer (Link et al., 2013; Reuter et al., 2011).[20, 21]

7.2 Strategies to Improve Bioavailability

Curcumin has shown promise in animal and laboratory trials, but its short half-life has prevented its widespread usage in humans.
This is because it is rapidly metabolized by the liver and poorly absorbed by the digestive tract. Various approaches

have been explored in an effort to resolve issue. The chemical piperine found in black pepper, when combined with curcumin, improves the absorption of curcumin by the body.
The action of piperine is to prolong the half-life of curcumin in the blood by decreasing its hepatic metabolism (Shoba et al., 1998).[16]
Liposomal Formulations: Curcumin is stabilized and more easily delivered to targeted areas of the body when encapsulated in small fat bubbles. Curcumin is protected from degradation and is able to penetrate cells more effectively due to these bubbles (Ghosh et al., 2011).[17]
Methods Based on Nanoparticles: By incorporating nanotechnology, such as encapsulating curcumin in small particle packages derived from polymers or green tea chemicals, the dissolving, transport, and sustained activity of curcumin can be enhanced. According to Alllapu et al. (2012), this approach enhances the absorption of curcumin by targeting specific tissues.[18] in
The phytosome method, which combines curcumin with phospholipids, facilitates its passage across the intestinal and gastric linings.
In addition to increasing curcumin bioavailability, these mixtures stabilize curcumin in the circulation, resulting in a more uniform impact (Maiti et al., 2007).The year 19

7.3 Findings in Specific Cancers

Extensive research on curcumin's anti-cancer properties across various cancer types has demonstrated its potential as an adjuvant treatment for cancer.
Curcumin inhibits the growth and metastasis of breast cancer cells by acting on estrogen receptor (ER) pathways and the human epidermal growth factor 2 (HER2). Breast cancer cells are less able to metastasize and tumor growth can be halted in its tracks (Jiang et al., 2007).[25]
Colorectal Cancer: Curcumin has been shown to reduce the size and number of colon polyps in individuals with familial adenomatous polyposis (FAP). According to Carroll et al. (2011), curcumin prevents colon cancer via blocking the γ-catenin and COX-2 pathways.[10]
Curcumin hinders the process that permits cancer cells to migrate and metastasize by preventing the development of new blood vessels and halting the progression of pancreatic cancer (Kunnumakkara et al., 2017).[8]
Cancers of the Lungs and Prostates: Curcumin has an effect on the PI3K/Akt/mTOR and EGFR pathways, which are involved in cancer cell survival and resistance to treatment. Shehzad et al. (2013) found that curcumin can increase tumor responsiveness to conventional treatments by focusing on these specific pathways.[24]
Curcumin has multiple anti-cancer effects, as this review demonstrates.
It has the ability to aid the immune system, alter the environment surrounding tumors, and directly inhibit cancer cells. To ensure its efficacy in treating cancer, however, more efficient methods of delivering curcumin are required because it does not remain in the body for an extended period of time.

8. Results

Curcumin has several beneficial effects on cancer, according to both laboratory and real-world studies. Curcumin has been shown in animal studies to inhibit the progression of cancer. On its own or in combination with other cancer treatments, curcumin has shrunk tumors by 30–60%, according to studies. This is due to curcumin's effects on cell proliferation, blood vessel creation, and cancer cell spreading, all of which contribute to cancer's growth.
The fact that curcumin is compatible with conventional cancer treatments, such as radiation and chemotherapy, is another significant discovery.
Curcumin has the potential to increase the efficacy of these treatments by making cancer cells more vulnerable to them, according to the research. Additionally, it lessens the negative effects that are commonly associated with these medicines. This solves a major problem with conventional cancer treatments: the damage they do to healthy tissues. Patients will have better results with less of it. Fewer adverse effects, such as skin problems, persistent fatigue, and nausea, are reported when patients incorporate curcumin into their cancer treatment plans. This provides more evidence that curcumin can alleviate some of the discomfort and anxiety associated with long-term therapy regimens.
Curcumin aids the immune system and fights cancer directly.
It has the ability to activate immune cells and regulate the production of specific substances in the body. This aids in controlling the inflammation and weight loss that can accompany cancer. Curcumin can make a difference in the lives of cancer patients by bolstering their immune systems, which in turn helps with symptom management and general health.
Numerous investigations have highlighted various issues and restrictions, nevertheless the promising outcomes. The current state of the art in cancer treatment is limited to research and supplementary methods, as no product containing curcumin has received official approval for routine usage. Furthermore, it appears that variables such as cancer stage, cancer kind, age, gender, or genetic composition influence the efficacy of curcumin. For these reasons, it is difficult to generalize about the efficacy of curcumin. The fact that curcumin is poorly absorbed by the body is another major concern. Little of it gets to the areas where it's needed because it doesn't absorb well, is broken down fast, and leaves the body fast. The effectiveness of curcumin in real-world settings cannot be predicted because individuals have varying reactions to these challenges. Therefore, in order to increase curcumin's efficacy, new delivery systems are required.

9. Conclusion

Turmeric derives its primary active ingredient, curcumin, from the Curcuma longa plant's roots. Due to preliminary research suggesting it can impact numerous cancer-related bodily systems, it has emerged as a major focus in cancer research. As an example, it has the ability to inhibit pathways that prolong the survival of cancer cells, decrease proteins that promote cell growth, and initiate cell death in cancer cells. By reducing inflammation, blocking the formation of new blood vessels, and altering the

communication between cancer cells and other cells in the body, curcumin can also alter the environment surrounding tumors. Because of its unique mechanisms of action, curcumin has great promise as an adjunct to conventional cancer therapies. Reducing the negative side effects of radiation and chemotherapy while simultaneously making cancer cells more responsive to these treatments is the goal of some research. These characteristics suggest that curcumin may be a helpful component of combination treatment programs for cancer patients.
Curcumin has shown promise in the lab, but there have been significant obstacles that have made it difficult to develop it into a practical medication for humans. The fact that curcumin is poorly absorbed by the body is a major concern. It has a poor solubility in water and is thus difficult for the digestive system to absorb by the body. The liver swiftly converts even minute amounts into inactive forms, which are then eliminated from the body, as soon as they enter the bloodstream. This means that the amount of curcumin in the body is insufficient to effectively combat cancer. This is why the beneficial effects observed in animals and labs do not necessarily translate to humans.
Another issue is that curcumin administration is not standardized.
A few hundred milligrams is the lowest dose used in certain research, whereas several grams is the highest. Turmeric powder, extracts, or specialized delivery systems like phytosomal complexes, liposomes, or nanoparticles are just a few examples of the many ways it can be delivered. Because of this, determining the optimal approach or comparing study findings becomes quite challenging. Larger investigations or approval from health authorities are hindered in the absence of precise instructions on dosage and form.
There is a lack of sufficient strong evidence from human studies, which brings up an additional difficulty. The human body is more complicated, particularly when it comes to the processing and reactions to chemicals, so while curcumin may have cancer-fighting properties in animals and lab studies, these findings don't necessarily translate to humans. Most human trials conducted thus far have been quite modest and have mostly focused on safety rather than efficacy. There is insufficient evidence to conclude that curcumin is a viable cancer treatment option at this time. If we want to know if curcumin helps cancer patients, we need more big, well-designed studies with defined guidelines. Also, there are still some real-world issues with getting curcumin to function as intended. Supplements and regular turmeric don't deliver enough curcumin, the active component, to the blood or cancer tissues to be effective. Scientists are currently devoting more resources to exploring novel delivery systems for curcumin, such as microscopic particles, specialized bubbles, fat-like structures, and other cutting-edge approaches. These novel methodologies have promising results in increasing curcumin absorption and duration in the bloodstream, both of which contribute to the spice's efficacy. Nevertheless, these techniques have not yet been certified for medical usage and are still in the testing phase. The actual advantages of curcumin in treating illnesses like cancer are still only theories unless they are created and authorized.
Another consideration is that turmeric is derived from plants, and the quantity of curcumin might vary based on factors such as cultivation conditions, storage methods, and final destination.
The quality of turmeric supplement items is also an issue. Products may not always be pure, may contain unwanted ingredients, or may not be consistently manufactured. Since the concentration of curcumin in various products might vary, it becomes challenging for researchers to conduct credible studies.
Curcumin has few known adverse effects and may interact with other medications, despite its generally low risk of harm.
Abdominal pain, allergic reactions, and, extremely rarely, liver damage might result from exceedingly high dosages. Additionally, it has the potential to alter the efficacy or safety of some medications, including blood thinners and cancer treatments. This emphasizes the significance of conducting thorough studies to confirm the safety and efficacy of curcumin before its use in cancer treatment.

10. Recommendations

This study adds to the growing body of evidence suggesting curcumin may be useful in the fight against and treatment of cancer.
We require a well-structured strategy that addresses numerous aspects before we can implement it in actual healthcare settings. The most important thing is to immediately begin large-scale, well-designed research including many types of cancer patients and numerous facilities. Research on curcumin should focus on its efficacy as well as its safety profile, both when taken alone and in combination with more conventional treatments. This includes determining the optimal dosage and duration of administration. Furthermore, in order to ensure the reliability and repeatability of the results, it is imperative that curcumin products be prepared and administered consistently across all investigations.
Altering the current method of curcumin administration is another important focus.
Curcumin might be administered more effectively, retained in the body for a longer period of time, and reach cancer cells more directly if it were linked to other chemicals, used in specialized balls, or dissolved in fat. Laboratory animals must be subjected to these novel approaches before humans may be considered. Furthermore, it is crucial to understand how various populations respond to curcumin and how it affects their health, particularly in cases where metabolic or liver disorders are present. We also recommend investigating the potential synergistic effects of curcumin with conventional cancer treatments, such as radiation and chemotherapy, since this could lead to a reduction in drug dosage while simultaneously improving safety and efficacy.
Particularly for cancer patients already on a heavy medication regimen, long-term safety studies of curcumin are urgently required.
Blood-thinning medications, immune-system modulators, and cancer cell killers are just a few examples of the types of drugs that curcumin may interact with.
It is important to advocate for the integration of curcumin research into cancer care teams outside of the laboratory.

Working together, medical professionals, pharmaceutical specialists, and dietitians can discover safe ways to incorporate curcumin into treatment plans. Additionally, it is important to educate the public about curcumin so they understand its benefits and drawbacks. This will help dispel myths and discourage the use of potentially harmful supplements. Also, medical professionals should get curcumin science training so they can advise patients safely and clearly about the supplement.

Further research into curcumin's cancer-prevention effects in high-risk populations is necessary. In order to determine whether consuming turmeric or taking specific curcumin supplements can reduce the likelihood of developing cancer in individuals with hereditary or environmental risk factors, large-scale studies that follow populations over time are necessary. Additionally, researchers should not stop looking into curcumin's effects on gene activity, the immune system, and cellular processes. With this information, we can create more effective medications and find new ways to use curcumin. Because of potential genetic and metabolic differences in response to curcumin, studies into customized medicine are also crucial.

From a policy standpoint, it would be prudent for global health guidelines to consider including proven curcumin products into cancer treatment regimens that employ proven methodologies once additional strong data is available. So that consumers do not get curcumin supplements that are not only safe but also pure and powerful, health regulators should establish standards to that end. Finally, more funding should go into studies that translate lab findings into effective treatments, allowing curcumin to go from a research chemical to a legitimately authorized medical choice.

References:

1. Aggarwal, B. B., & Harikumar, K. B. (2009). Potential therapeutic effects of curcumin, the anti-inflammatory agent, against neurodegenerative, cardiovascular, pulmonary, metabolic, autoimmune and neoplastic diseases. *The International Journal of Biochemistry & Cell Biology*, *41*(1), 40–59.
2. Hatcher, H., Planalp, R., Cho, J., Torti, F. M., & Torti, S. V. (2008). Curcumin: From ancient medicine to current clinical trials. *Cellular and Molecular Life Sciences*, *65*(11), 1631–1652.
3. Gupta, S. C., Patchva, S., Koh, W., & Aggarwal, B. B. (2013). Discovery of curcumin, a component of golden spice, and its miraculous biological activities. *Clinical and Experimental Pharmacology and Physiology*, *39*(3), 283–299.
4. Goel, A., Kunnumakkara, A. B., & Aggarwal, B. B. (2008). Curcumin as "Curecumin": From kitchen to clinic. *Biochemical Pharmacology*, *75*(4), 787–809.
5. Kunnumakkara, A. B., Bordoloi, D., Harsha, C., Banik, K., Gupta, S. C., & Aggarwal, B. B. (2017). Curcumin mediates anticancer effects by modulating multiple cell signaling pathways. *Clinical Science*, *131*(15), 1781–1799.
6. Shanmugam, M. K., Rane, G., Kanchi, M. M., Arfuso, F., Chinnathambi, A., Zayed, M. E., Alharbi, S. A., Tan, B. K., Kumar, A. P., & Sethi, G. (2015). The multifaceted role of curcumin in cancer prevention and treatment. *Molecules*, *20*(2), 2728–2769.
7. Wilken, R., Veena, M. S., Wang, M. B., & Srivatsan, E. S. (2011). Curcumin: A review of anti-cancer properties and therapeutic activity in head and neck squamous cell carcinoma. *Molecular Cancer*, *10*(1), 12.
8. Anand, P., Kunnumakkara, A. B., Newman, R. A., & Aggarwal, B. B. (2007). Bioavailability of curcumin: Problems and promises. *Molecular Pharmaceutics*, *4*(6), 807–818.
9. Gupta, S. C., Sung, B., Kim, J. H., Prasad, S., Li, S., & Aggarwal, B. B. (2013). Multitargeting by curcumin as revealed by molecular interaction studies. *Natural Product Reports*, *30*(3), 494–513.
10. Aggarwal, B. B., Deb, L., & Prasad, S. (2015). Curcumin differs from tetrahydrocurcumin for molecular targets, signaling pathways and cellular responses. *Molecules*, *20*(1), 185–205.
11. Bar-Sela, G., Epelbaum, R., & Schaffer, M. (2010). Curcumin as an anti-cancer agent: Review of the gap between basic and clinical applications. *Current Medicinal Chemistry*, *17*(3), 190–197.
12. Cheng, A. L., Hsu, C. H., Lin, J. K., Hsu, M. M., Ho, Y. F., Shen, T. S., Ko, J. Y., Lin, J. T., Lin, B. R., Ming-Shiang, W., Yu, H. S., Jee, S. H., Chen, G. S., Chen, T. M., Chen, C. A., Lai, M. K., Pu, Y. S., Pan, M. H., Wang, Y. J., ... & Tsai, C. C. (2001). Phase I clinical trial of curcumin, a chemopreventive agent, in patients with high-risk or premalignant lesions. *Anticancer Research*, *21*(4B), 2895–2900.
13. Lao, C. D., Ruffin, M. T., Normolle, D., Heath, D. D., Murray, S. I., Bailey, J. M., Boggs, M. E., Crowell, J., Rock, C. L., & Brenner, D. E. (2006). Dose escalation of a curcuminoid formulation. *BMC Complementary and Alternative Medicine*, *6*, 10.
14. Dhillon, N., Aggarwal, B. B., Newman, R. A., Wolff, R. A., Kunnumakkara, A. B., Abbruzzese, J. L., Ng, C. S., Badmaev, V., & Kurzrock, R. (2008). Phase II trial of curcumin in patients with advanced pancreatic cancer. *Clinical Cancer Research*, *14*(14), 4491–4499.
15. Carroll, R. E., Benya, R. V., Turgeon, D. K., Vareed, S., Neuman, M., Rodriguez, L., Kakarala, M., Carpenter, P. M., McLaren, C., Meyskens, F. L., & Brenner, D. E. (2011). Phase IIa clinical trial of curcumin for the prevention of colorectal neoplasia. *Cancer Prevention Research*, *4*(3), 354–364.
16. Nelson, K. M., Dahlin, J. L., Bisson, J., Graham, J., Pauli, G. F., & Walters, M. A. (2017). The essential medicinal chemistry of curcumin. *Journal of Medicinal Chemistry*, *60*(5), 1620–1637.
17. Hewlings, S. J., & Kalman, D. S. (2017). Curcumin: A review of its effects on human health. *Foods*, *6*(10), 92.
18. Shoba, G., Joy, D., Joseph, T., Majeed, M., Rajendran, R., & Srinivas, P. S. (1998). Influence of piperine on the pharmacokinetics of curcumin in animals and human volunteers. *Planta Medica*, *64*(4), 353–356.
19. Tomeh, M. A., Hadianamrei, R., & Zhao, X. (2019). A review of curcumin and its derivatives as anticancer

agents. *International Journal of Molecular Sciences*, *20*(5), 1033.
20. Yallapu, M. M., Jaggi, M., & Chauhan, S. C. (2012). Curcumin nanoformulations: A future nanomedicine for cancer. *Drug Discovery Today*, *17*(1-2), 71–80.
21. Priyadarsini, K. I. (2014). The chemistry of curcumin: From extraction to therapeutic agent. *Molecules*, *19*(12), 20091–20112.
22. Basnet, P., & Skalko-Basnet, N. (2011). Curcumin: An anti-inflammatory molecule from a curry spice on the path to cancer treatment. *Molecules*, *16*(6), 4567–4598.
23. Aggarwal, B. B., & Sung, B. (2009). Pharmacological basis for the role of curcumin in chronic diseases: An age-old spice with modern targets. *Trends in Pharmacological Sciences*, *30*(2), 85–94.
24. Prasad, S., Tyagi, A. K., & Aggarwal, B. B. (2014). Recent developments in delivery, bioavailability, absorption, and metabolism of curcumin: The golden pigment from golden spice. *Cancer Research and Treatment*, *46*(1), 2–18.
25. Shehzad, A., Rehman, G., Lee, Y. S., & Lee, Y. S. (2013). Curcumin in inflammatory diseases. *BioFactors*, *39*(1), 69–77.