IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"Unveiling the Golden Spice:A Comprehensive Review of Curcumin's Health Benefits and Therapeutic Potential"

Payal Sawant1, Pragati Soni2, Tejasvini Shevale3, Nimisha Singh4, Trunali Ghude5

1. Konkan Gnyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra, India.

2. Konkan Gnyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra, India.

3. Konkan Gnyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra, India.

4. Konkan Gnyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra, India.

5. Assistant Professor Department of Pharmaceutics, Konkan Gnyanpeeth Rahul Dharkar College of Pharmacy and Research Institute, Karjat, Maharashtra, India.

ABSTRACT:

Curcuma longa, commonly known as turmeric, has garnered significant attention in recent years due to its diverse pharmacological properties and potential health benefits. This review provides a comprehensive overview of the medicinal properties, bioactive compounds, pharmacokinetics, and therapeutic applications of Curcuma longa. Its principal bioactive component, curcumin, has been extensively studied for its anti-inflammatory, antioxidant, antimicrobial, and anticancer properties. Additionally, Curcuma longa demonstrates promising effects in the management of various chronic diseases such as cardiovascular disorders, neurodegenerative diseases, and metabolic syndromes. Despite its remarkable therapeutic potential, challenges such as poor bioavailability and limited clinical evidence remain. Strategies to enhance the bioavailability of curcumin, including the use of adjuvants and novel delivery systems, are discussed. Furthermore, the safety profile and potential adverse effects associated with Curcuma longa consumption are addressed. Overall, this review underscores the importance of Curcuma longa as a valuable natural remedy and highlights avenues for future research and clinical applications.

Keywords: Curcuma longa, Ayurveda, Anti-inflammatory, Antioxidant, Cancer Prevention, Immunomodulatory effect, Neuroprotection.

INTRODUCTION:

The question of whether modern medicines are safer, more efficacious, and more affordable than generic medicines or ancient remedies often results in a "no" for many contemporary drugs. This has led to a growing interest in revisiting and reviving age-old medicines for the benefit of humanity. One such ancient remedy is

curcumin, derived from the turmeric plant (Curcuma longa), whose use dates back over 5000 years to the era of Ayurveda, the traditional Indian system of medicine.

Figure 1 Curcumin Plant[1]

Turmeric, with its vibrant golden color, has been used in the Indian subcontinent for centuries, not only as a culinary spice but also as a medicinal herb with no known side effects. In Europe, it earned the nickname “Indian saffron” due to its color and flavour. India remains the largest exporter of turmeric, known locally as Haldi. While turmeric is well-known for its ability to preserve food through its antioxidant properties, add color, and enhance flavour, its health benefits are less widely recognized.

Figure 2 Turmeric rhizome[2]

Historically, turmeric has been used to treat a variety of ailments. It was once considered a remedy for jaundice, an appetite suppressant, and a digestive aid. In traditional Indian and Chinese medicine, turmeric has been employed as an anti-inflammatory agent to address gas, colic, toothaches, chest pains, and menstrual issues. Additionally, it has been used to treat stomach and liver problems, heal wounds, reduce scarring, and even as a cosmetic. Turmeric's significance was noted by Marco Polo during his travels to China and India in 1280. Arab traders introduced it to Europe in the 13th century, and it was further popularized by Vasco da Gama, the Portuguese explorer, in the 15th century. However, it was during British colonial rule in India that turmeric was mixed with other spices and became known in the West as "curry powder.” This review will explore the therapeutic potential of turmeric, specifically focusing on curcumin, the active component. We will examine how curcumin exerts its effects, the receptors it interacts with, and the diseases it is effective against. Through this exploration, we aim to highlight the enduring value of this ancient remedy in modern times.[3]

HISTORICAL AND TRADITIONAL USE:

Turmeric, derived from the dried rhizome of the Curcuma longa Linn plant, is renowned for imparting the characteristic yellow hue to curry powder, widely utilized in both culinary and traditional practices. Its historical significance dates back over 5000 years, featuring prominently in Indian Traditional Medicine (Ayurveda) and Traditional Chinese Medicine, and continues to be integrated into Asian cuisine today. Turmeric's journey spans continents and centuries, with records indicating its presence in China by AD 700, East Africa by AD 800, West Africa by AD 1200, and Jamaica in the 18th century. Marco Polo, in 1280,

likened turmeric to saffron, noting its color and aroma. Ancient texts, including Susruta's Ayurvedic Compendium from 250 BC, document its use in medicinal preparations, including ointments for food poisoning relief.

Figure 3 Distribution of Turmeric

In Southeast Asia, turmeric holds cultural significance, used in religious ceremonies and traditional rituals such as body dyeing for wedding ceremonies. Its vivid yellow pigment earned it the moniker "Indian Saffron" in medieval Europe. Medicinally, turmeric has been utilized across Asia for treating stomach and liver ailments, wound healing, and addressing various skin conditions, from smallpox to minor cuts. In China, it is administered orally or topically for inflammatory joint conditions and skin allergies.

The discovery of curcumin, the bioactive compound within turmeric, dates back approximately two centuries. Vogel and Pelletier first isolated "yellow colouring-matter" from turmeric rhizomes in 1815, naming it curcumin. Its chemical structure was elucidated in 1910, and its synthesis was achieved in 1913. Early studies in the 1930s documented curcumin's antibacterial properties and its ability to reduce blood sugar levels. The 1970s witnessed the unveiling of its diverse attributes, including cholesterol-lowering, anti-inflammatory, and antioxidant properties. It wasn't until the 1980s that curcumin's anticancer potential was demonstrated, paving the way for further research into its molecular mechanisms. Subsequent studies in the 1990s elucidated its role in suppressing proinflammatory pathways, solidifying its reputation as a potent anti-inflammatory agent.

The evolving interest in curcumin's therapeutic applications has spurred extensive research into its chemistry and medicinal properties, fuelling ongoing exploration of its potential benefits. This journey underscores the enduring relevance of ancient remedies in modern healthcare practices.[4]

MECHANISM OF ACTION:

The biological properties of turmeric, including its pleasant aroma, are attributed to essential oils such as ar-turmerone, α- and β-turmerones, β-caryophyllene, α-eucalyptol, and phellandrene. However, the most active compounds in turmeric are the polyphenols known as curcuminoids, with curcumin being the most abundant (77%), followed by desmethoxycurcumin (17%) and bis-desmethoxycurcumin (3%). Trace amounts of another natural analogue, cyclocurcumin, have also been detected in turmeric root extracts. Curcumin, also referred to as diferuloylmethane, is the most valuable compound in turmeric, belonging to the hydrophobic polyphenols category. It consists of two ferulic acid residues joined by a methylene bridge. Curcumin plays a pivotal role in turmeric's therapeutic properties, particularly its anti-inflammatory and antioxidant activities. Studies have demonstrated that curcumin can be beneficial in treating various disorders, including chronic diseases, inflammatory disorders, infections, and other pathological conditions. Its antioxidant properties stem from its ability to form phenoxy radicals or undergo direct hydrogen abstraction. Curcumin's hydroxyl residue is particularly vulnerable to radical attacks. Clinical studies have shown that curcumin is well-tolerated and exhibits systemic bioavailability. For instance, administration of 8 g of curcumin daily resulted in a peak concentration of 2 μM in blood serum, indicating no significant accumulation in the body. Furthermore, doses of up to 180 mg of curcumin per day were safely administered to patients with advanced colorectal cancer for up to 4 months without toxic effects or detectable systemic bioavailability. Overall, curcumin holds promise as a therapeutic agent for a wide range of conditions, and ongoing research continues to explore its potential benefits and mechanisms of action.[5]

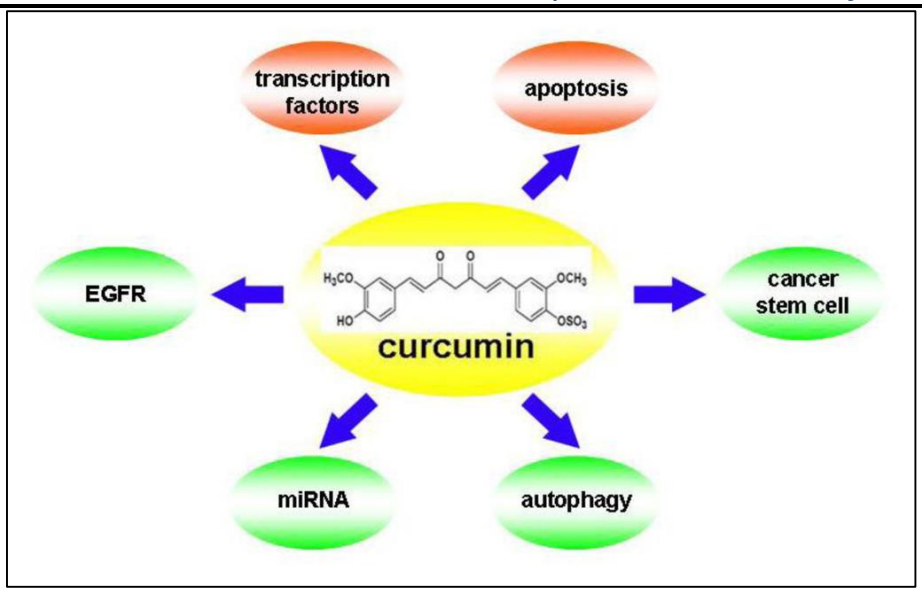

Figure 4 Mechanism of action of curcumin [6]

HEALTH BENEFITAND PHARMACOLOGICAL ACTION:

Curcumin has garnered global attention for its myriad health benefits, primarily attributed to its potent antioxidant and anti-inflammatory properties. These benefits are optimized when curcumin is combined with enhancers like piperine, which significantly enhance its bioavailability. Extensive research indicates that curcumin holds potential in managing oxidative stress and inflammation, metabolic syndrome, arthritis, anxiety, and hyperlipidaemia. Moreover, it may aid in alleviating exercise-induced inflammation and muscle soreness, thereby promoting quicker recovery and improved performance in physically active individuals. Remarkably, even at relatively low doses, curcumin offers health advantages for individuals without diagnosed health conditions.[7]

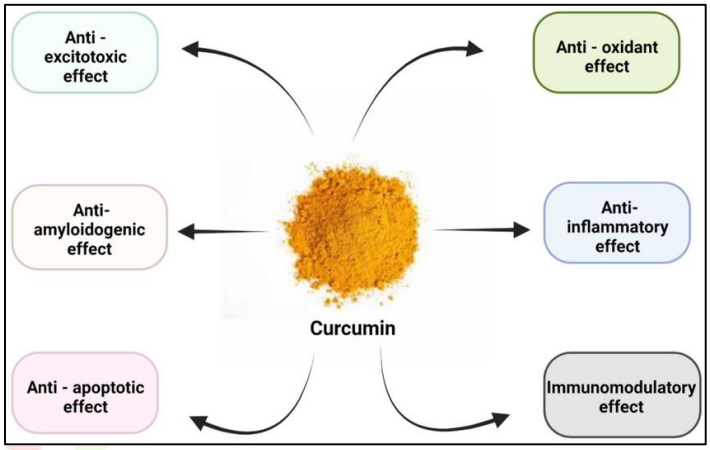

Figure 5 Pharmacological effect of curcumin[8]

A. ANTI-OXIDANT& ANTI-INFLAMMATORY EFFECT:

Nearly five decades have passed since Denham Harman first proposed the idea that free radicals, generated during aerobic respiration, contribute to cumulative oxygen damage, ultimately leading to aging and mortality. Oxygen is indispensable for cellular functions, particularly in ATP production, yet it also assumes dual roles. While vital, oxygen can also be transformed into reactive oxygen species (ROS), highly reactive molecules that can be detrimental to cells. Approximately 2% of oxygen reduced by mitochondria results in the formation of superoxide (O2-) or its dismutation product, hydrogen peroxide (H2O2). These species can react with metal ions, promoting further radical generation, notably hydroxyl radicals. Hydroxyl radicals are particularly destructive, reacting with various cellular components such as lipid membranes, DNA, and proteins. Nitric oxide (NO), though physiologically essential for vasorelaxation, neurotransmission, and immune defense, can also act as a free-radical species. Interaction between NO and superoxide results in the formation of peroxynitrite (ONOO-), a potent oxidant capable of damaging DNA and hindering repair mechanisms. The production of reactive nitrogen species (RNS) by NO further contributes to cellular damage. The preventive and therapeutic potential of curcumin has been linked to its antioxidant properties. Given that free radical-mediated peroxidation of lipids, and oxidative damage to DNA and proteins, are implicated in numerous chronic diseases such as cancer, atherosclerosis, neurodegenerative disorders, and aging, curcumin's role in combating oxidative stress-related conditions is significant. Consequently, extensive research has been dedicated to elucidating curcumin's antioxidant activity. Understanding the interplay between free radicals and antioxidants is crucial in both health and disease contexts. Antioxidants, including curcumin, neutralize free radicals, mitigating oxidative damage and potentially preventing or ameliorating various pathological conditions.[9]

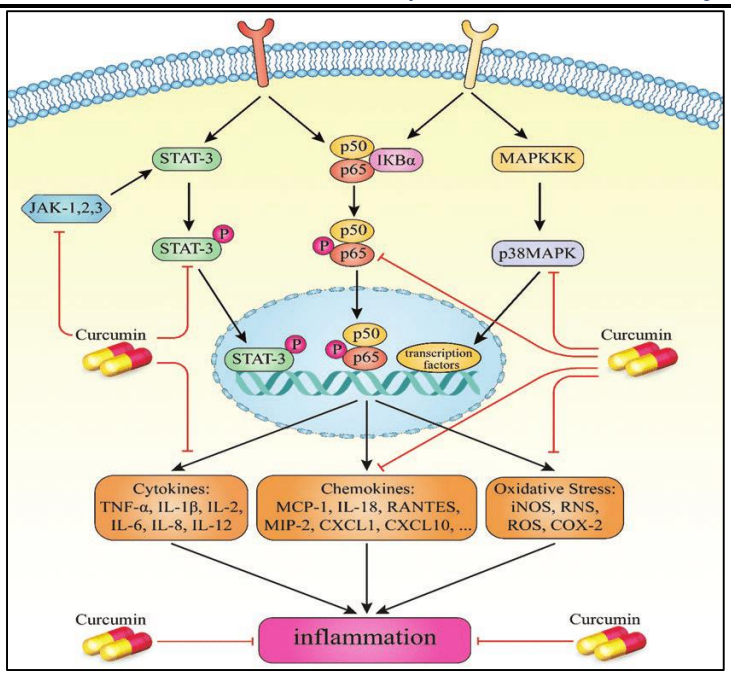

Figure 6 Anti-inflammatory effect of Curcumin[10]

B. POTENTIAL ROLE IN CANCER PREVENTION AND TREATMENT:

Since 1987, the National Cancer Institute (NCI) has evaluated over 1,000 potential chemo preventive agents, with only about 40 showing promise and advancing to clinical trials.[11] Curcumin, found in the Indian spice "Haldi" is among these agents currently under investigation for cancer prevention. Curcumin is the most abundant and extensively studied polyphenol isolated from Curcuma longa. [12]Historically used in various cultures as a remedy for numerous ailments, curcumin's potential in cancer prevention and therapy-related complications has gained attention in recent decades. The first clinical evidence of its anticancer properties came from Kuttan and colleagues, who observed a reduction in Odor, pain, and lesion size in patients with skin cancerous lesions treated with a 1% curcumin ointment. In animal models, curcumin demonstrated efficacy in reducing mammary adenocarcinoma initiation induced by 7,12-dimethylbenz-[a]-anthracene (DMBA), preventing oesophageal cancer initiation and post-initiation phases, and inhibiting adenoma development in familial adenomatous polyposis (FAP)-simulated studies.[13]

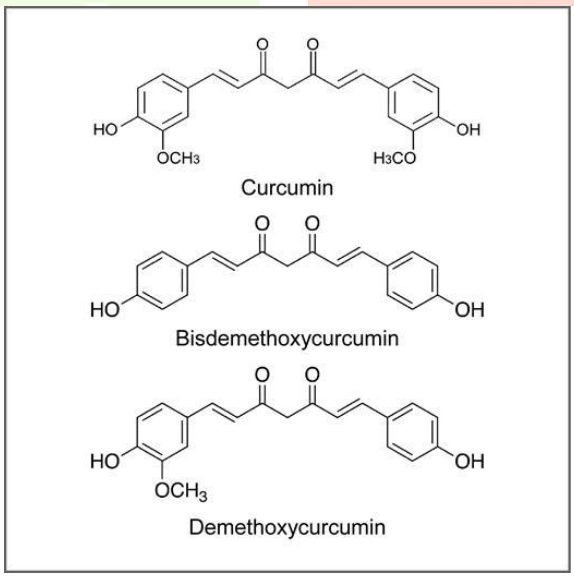

Figure 7 Molecular structure of Curcumin

Furthermore, curcumin showed promise in preventing hepatic cancer induced by N-nitrosodiethylamine and phenobarbital in rats by reducing lipid peroxidation and enhancing hepatic glutathione antioxidant defense. Curcumin exhibits multi-targeted anticancer and chemo preventive effects, acting as antiproliferative, antioxidant, and carcinogen-blocking agent.[14] Its mechanisms of action involve regulation of programmed cell death and survival signals, targeting various transcription factors, growth factors, inflammatory cytokines, receptors, and enzymes involved in signalling pathways. These actions include reduction of survival signals, promotion of proapoptotic pathways, anti-inflammatory effects, and scavenging of reactive oxygen species (ROS).[15] The complex mechanisms underlying curcumin's effects on signalling pathways are currently under intense investigation, particularly regarding its chemo preventive, chemo sensitizing, and radio sensitizing effects. Overall, curcumin holds significant potential as a multifaceted agent for cancer

prevention and therapy, with ongoing research aimed at further elucidating its mechanisms of action and therapeutic applications.[16]

C. BENEFITS FOR BRAIN HEALTH AND NEUROPROTECTION:

Neurodegenerative diseases (NDDs) are a significant global health concern, characterized by a gradual decline in neurological function and neuronal cell death. Alzheimer's disease (AD), Huntington's disease (HD), Parkinson's disease (PD), amyotrophic lateral sclerosis (ALS), and prion diseases are among the most challenging to manage due to their complex pathological mechanisms involving amyloid protein aggregates.

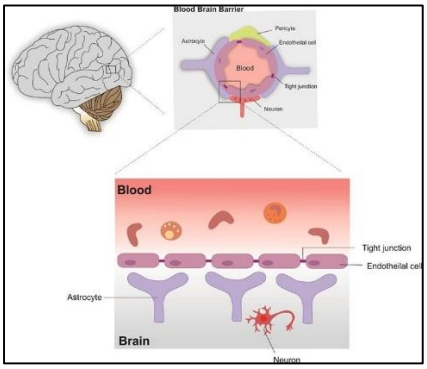

Figure 8 Brain Health

Therapeutic strategies aimed at slowing or halting NDD progression have been largely ineffective, focusing on symptom management rather than disease modification. Curcumin, a polyphenolic compound derived from turmeric, has attracted attention for its potential neuroprotective effects, including anti-amyloid, antioxidant, and anti-inflammatory properties. It has shown promise in reducing nitric oxide concentration, protecting against lipid peroxidation, preventing amyloid formation, and exhibiting therapeutic activity against brain tumours. However, the utility of curcumin is hindered by its poor bioavailability, attributed to factors such as limited absorption, metabolic instability, rapid elimination, and restricted blood-brain barrier (BBB) permeability. The BBB, composed of endothelial cells, astrocytes, and pericytes, acts as a selective barrier to prevent the entry of many drugs and large molecules into the brain. Tight junctions between brain capillary endothelial cells, high expression of efflux transport proteins (e.g., MRP-1, P-GP, BCRP), and the presence of degrading enzymes contribute to the BBB's impermeability. While essential for protecting the brain from toxic substances, the BBB also poses a challenge in drug delivery for NDD treatment. Research aimed at improving BBB penetration holds promise for overcoming this obstacle. Novel strategies and pharmaceutical formulations are being explored to enhance the transport of drugs like curcumin into the brain. This review provides a concise overview of BBB permeation strategies, focusing on curcumin transport and its reported effects from experimental studies.[17]

D. ROLE IN CARDIOVASCULAR HEALTH:

Curcumin exerts cardioprotective effects against various cardiovascular insults, including ischemia-reperfusion injury, myocardial infarction, and drug-induced cardiotoxicity. It helps preserve myocardial function, reduce myocardial damage, and improve cardiac remodelling following injury. Curcumin's ability to modulate apoptotic pathways, attenuate oxidative stress, and inhibit inflammatory responses contributes to its cardioprotective properties. Vasodilatory effects: Curcumin promotes vasodilation by enhancing endothelial function and increasing nitric oxide (NO) production. NO is a key regulator of vascular tone, and impaired NO bioavailability is associated with endothelial dysfunction and hypertension. By enhancing NO-mediated vasodilation, curcumin improves blood flow regulation, lowers blood pressure, and reduces the risk of hypertension-related cardiovascular complications.[18]

SAFETY AND SIDE EFFECT:

Curcumin is generally safe, but side effects can occur at high doses or after long-term use. These side effects include:

- Digestive issues: Bloating, acid reflux, flatulence, diarrhoea, nausea, and stomach ulcers
- Headache: Doses of 450 mg or higher may cause headaches in some people
- Skin rash: Doses of 8,000 mg or more may cause a skin rash, but this is rare
- Yellow stool: High doses of curcumin may cause yellow stool [19]

CONCLUSION:

In conclusion, the diverse and multifaceted therapeutic potential of curcumin illuminated through this comprehensive review underscores its status as a remarkable natural compound with profound implications for human health. From its ancient roots in traditional medicine to its modern-day exploration in cutting-edge research, curcumin stands as a beacon of hope in the pursuit of novel therapeutic strategies for various ailments, including cardiovascular diseases, neurodegenerative disorders, cancer, and beyond. As we navigate the complexities of modern healthcare, the journey of curcumin serves as a testament to the enduring wisdom of traditional healing practices and the relentless pursuit of scientific innovation. Its remarkable versatility, from its potent anti-inflammatory and antioxidant properties to its ability to modulate diverse signalling pathways, embodies the intricate interplay between nature's bounty and human ingenuity. However, amidst the excitement surrounding curcumin's therapeutic promise, challenges remain. Issues such as poor bioavailability, limited systemic distribution, and variable clinical outcomes underscore the need for continued research and innovation. By harnessing the power of interdisciplinary collaboration, technological advancements, and targeted drug delivery systems, we can unlock the full potential of curcumin and pave the way for personalized and precision medicine approaches tailored to individual patient needs. In the tapestry of modern medicine, curcumin emerges not only as a molecule of profound biological significance but also as a symbol of resilience, adaptability, and the enduring quest for better health and well-being. As we embark on the next chapter of scientific discovery, let us heed the lessons of curcumin's journey – to embrace the wisdom of the past, to embrace the challenges of the present, and to embrace the possibilities of the future in our ongoing quest for optimal health and vitality.

REFERENCES:

[1] "Turmeric Grow Guide - The Gourmantic Garden." Accessed: May 21, 2024. [Online]. Available: https://thegourmanticgarden.com/how-to-grow-turmeric/

[2] "Turmeric Powder vs Raw Turmeric Root: What's better? | The Times of India." Accessed: May 21, 2024. [Online]. Available: https://timesofindia.indiatimes.com/life-style/food-news/turmeric-powder-vs-raw-turmeric-root-whats-better/photostory/97940833.cms

[3] B. B. Aggarwal, C. Sundaram, N. Malani, and H. Ichikawa, "CURCUMIN: THE INDIAN SOLID GOLD," *Adv Exp Med Biol*, vol. 595, pp. 1–75, 2007, doi: 10.1007/978-0-387-46401-5_1.

[4] T. Farooqui and A. A. Farooqui, "Curcumin: Historical Background, Chemistry, Pharmacological Action, and Potential Therapeutic Value," *Curcumin for Neurological and Psychiatric Disorders: Neurochemical and Pharmacological Properties*, pp. 23–44, Jan. 2019, doi: 10.1016/B978-0-12-815461-8.00002-5.

[5] P. Liczbiński, J. Michałowicz, and B. Bukowska, "Molecular mechanism of curcumin action in signaling pathways: Review of the latest research," *Phytotherapy Research*, vol. 34, no. 8, pp. 1992–2005, Aug. 2020, doi: 10.1002/PTR.6663.

[6] M. X. Ye, Y. Li, H. Yin, and J. Zhang, "Curcumin: Updated Molecular Mechanisms and Intervention Targets in Human Lung Cancer," *International Journal of Molecular Sciences 2012, Vol. 13, Pages 3959-3978*, vol. 13, no. 3, pp. 3959–3978, Mar. 2012, doi: 10.3390/IJMS13033959.

[7] S. J. Hewlings and D. S. Kalman, "Curcumin: A Review of Its' Effects on Human Health," *Foods*, vol. 6, no. 10, Oct. 2017, doi: 10.3390/FOODS6100092.

[8] Y. Hussain *et al.*, "Regulatory Effects of Curcumin on Platelets: An Update and Future Directions," *Biomedicines*, vol. 10, no. 12, Dec. 2022, doi: 10.3390/BIOMEDICINES10123180.

[9] V. P. Menon and A. R. Sudheer, "ANTIOXIDANT AND ANTI-INFLAMMATORY PROPERTIES OF CURCUMIN," *Adv Exp Med Biol*, vol. 595, pp. 105–125, 2007, doi: 10.1007/978-0-387-46401-5_3.

[10] A. Mohammadi *et al.*, "Nanomicellar Curcumin Supplementation Improves the Clinical Manifestations of HAM/TSP Patients," *Adv Exp Med Biol*, vol. 1328, pp. 347–359, 2021, doi: 10.1007/978-3-030-73234-9_22.

[11] A. Amin, O. Kucuk, … F. K.-J. of clinical, and undefined 2009, "Perspectives for cancer prevention with natural compounds," *ncbi.nlm.nih.govARMR Amin, O Kucuk, FR Khuri, DM ShinJournal of clinical oncology, 2009•ncbi.nlm.nih.gov*, Accessed: May 21, 2024. [Online]. Available: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2690394/

[12] R. Kuttan, P. C. Sudheeran, and C. D. Josph, "Turmeric and curcumin as topical agents in cancer therapy," *Tumori*, vol. 73, no. 1, pp. 29–31, 1987, doi: 10.1177/030089168707300105.

[13] K. Singletary, C. MacDonald, M. Wallig, C. F.-C. letters, and undefined 1996, "Inhibition of 7, 12-dimethylbenz anthracene (DMBA)-induced mammary tumorigenesis and DMBA-DNA adduct formation by curcumin," *ElsevierK Singletary, C MacDonald, M Wallig, C FisherCancer letters, 1996•Elsevier*, Accessed: May 21, 2024. [Online]. Available: https://www.sciencedirect.com/science/article/pii/0304383596042243

[14] J. Ushida *et al.*, "Chemopreventive Effect of Curcumin on N-Nitrosomethylbenzylamine-induced Esophageal Carcinogenesis in Rats," *Wiley Online LibraryJ Ushida, S Sugie, K Kawabata, QV Pham, T Tanaka, K Fujii, H Takeuchi, Y Ito, H MoriJapanese journal of cancer research, 2000•Wiley Online Library*, vol. 91, no. 9, pp. 893–898, 2000, doi: 10.1111/j.1349-7006.2000.tb01031.x.

[15] J. A. Brennan *et al.*, "Association between Cigarette Smoking and Mutation of the p53 Gene in Squamous-Cell Carcinoma of the Head and Neck," *New England Journal of Medicine*, vol. 332, no. 11, pp. 712–717, Mar. 1995, doi: 10.1056/NEJM199503163321104.

[16] W. Park, A. R. M. Ruhul Amin, Z. G. Chen, and D. M. Shin, "New perspectives of curcumin in cancer prevention," *Cancer Prevention Research*, vol. 6, no. 5, pp. 387–400, May 2013, doi: 10.1158/1940-6207.CAPR-12-0410/36393/AM/NEW-PERSPECTIVES-OF-CURCUMIN-IN-CANCER.

[17] A. Askarizadeh, G. E. Barreto, N. C. Henney, M. Majeed, and A. Sahebkar, "Neuroprotection by curcumin: A review on brain delivery strategies," *Int J Pharm*, vol. 585, p. 119476, Jul. 2020, doi: 10.1016/J.IJPHARM.2020.119476.

[18] H. Li *et al.*, "Curcumin, the golden spice in treating cardiovascular diseases," *Biotechnol Adv*, vol. 38, p. 107343, Jan. 2020, doi: 10.1016/J.BIOTECHADV.2019.01.010.

[19] "Turmeric and Curcumin: Health, Spice, and Supplement Information From WebMD." Accessed: May 21, 2024. [Online]. Available: https://www.webmd.com/diet/supplement-guide-turmeric