e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

THE ROLE OF CURCUMIN IN HEALTH PROMOTION AND DISEASE PREVENTION: A COMPREHENSIVE REVIEW

Amit Singh[*1], Mr. Pramod Mishra[*2], Mr. Sujeet Pratap Singh[*3], Dr. Tarkeshwar Prasad Shukla[*4]

[*1]Student Of B. Pharm, SCPM College Of Pharmacy, Gonda, U.P, India.

[*2,3]Asst. Prof., Department Of Pharmaceutics, SCPM College Of Pharmacy, Gonda, U.P, India.

[*4]Principal, Department Of Pharmaceutics, SCPM College Of Pharmacy, Gonda, U.P, India.

DOI : https://www.doi.org/10.56726/IRJMETS64035

ABSTRACT

Curcumin, which is the major bioactive compound found in Curcuma longa (turmeric), has drawn a lot of interest owing to its numerous health benefits, especially in the fields of disease prevention and health promotion. This review goes into detail on understanding the molecular mechanisms of curcumin's biological activities, especially its anti-inflammatory, antioxidant, anticancer, and neuroprotective properties. Curcumin is known to affect major cellular signaling pathways like NF-κB, MAPK, and PI3K/Akt to down-regulate inflammation and oxidative stress, which are critical for the development of many chronic diseases. Furthermore, curcumin's role in cancer, cardiovascular diseases, diabetes, Alzheimer's disease, arthritis management or mitigation, as well as immune enhancement has also been assessed. Nonetheless, the clinical use of curcumin is often compromised by its inadequate bioavailability leading to the development of novel drug delivery systems and bioenhancers. In spite of these setbacks, curcumin, because of its non-specificity, low toxicity and various biological effects, presents good possibilities for use in the development of new therapeutic regimens. In this review, we also address the recent trends in curcumin formulations such as: modern approaches towards improving curcumin therapy like nanomedicine and nanocarrier encapsulation. Most of the results gathered from preclinical studies show positive outcomes; however, it is necessary to conduct more clinical trials on curcumin to provide clear therapeutic indications. The review emphasizes the potential use of curcumin in the form of a phytochemical, as it imparts positive health effects and helps in preventing diseases.

Keywords: Herbal Medicine, Turmeric, Spice, Curcuma, Polyphenols, Bioactive Compound.

I. INTRODUCTION

Curcumin, a vibrant yellow compound extracted from Curcuma longa (turmeric), has long been esteemed for its medicinal attributes spanning diverse cultures for centuries. Renowned for its anti-inflammatory, antioxidant, and anticancer properties, curcumin has garnered substantial interest in modern health studies. In the face of escalating global health challenges posed by chronic ailments like cancer, cardiovascular diseases, diabetes, and neurodegenerative conditions, the quest for natural substances with preventive and therapeutic capacities has intensified. With its multifaceted biological functions, curcumin stands out as a promising candidate in promoting health and averting diseases.

Aim of the Review

The main objective of this review is to investigate the impact of curcumin on promoting health and its potential for preventing different chronic diseases. By analyzing the latest scientific research, this review aims to clarify the molecular mechanisms that drive the effects of curcumin, its potential for therapy, and the obstacles faced in its clinical application, particularly in terms of bioavailability.

Many studies have investigated the many biological properties of curcumin. Early research focused on its antioxidant and anti-inflammatory effects, identifying curcumin's ability to scavenge reactive oxygen species (ROS) and inhibit pro-inflammatory cytokines involved in many diseases . Recent studies have broadened the understanding of the molecular mechanisms of curcumin, showing its effects on important signaling pathways such as NF-κB, MAPK, and PI3K/Akt that regulate the immune response, the survival of cells, and apoptosis . In addition, curcumin has been studied for its anti-cancer properties, and studies have shown its ability to inhibit tumor growth, metastasis and angiogenesis in various cancer models .Despite promising results from

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

preliminary studies, the clinical use of curcumin is limited by its bioavailability because it is rapidly absorbed and excreted in the body. Therefore, significant research has focused on improving bioavailability through novel drug delivery systems, including bio-based nanoparticles and bio-enhancerr. In addition, clinical trials have begun to investigate the efficacy of curcumin in treating or preventing diseases such as Alzheimer's disease, arthritis, and heart disease, with early but promising results (Jiang and Wang, 2019).

CLASSIFICATION OF CURCUMIN

Kingdom: Plantae

Subkingdom: Tracheobionts

Division order: Mangoliophyta

Family: Zingiberaceae

Genus: Zingiberales

Species: Longa

Scientific name: Curcuma longa

II. HISTORICAL PERSPECTIVE OF CURCUMIN

Curcumin, which is turmeric's (Curcuma longa) main bioactive component, has a history of its own deeply embedded in the cultural, medicinal, and culinary practices of South Asia. Turmeric's utilization is known to date back to over 4000 years during India's Vedic period when it was first recognized in Ayurvedic medicine as Haridra-the golden spice. The ancient Ayurvedic texts heralded turmeric's curative properties and recommended it for an array of ailments that included digestive disorders, respiratory malaise, and inflammatory disorders. Turmeric also symbolized purity and prosperity and health in Hindu rituals, testimony to the great esteem in which it was held.

From the 7th century onwards, turmeric entered China and by the 8th century, East Africa saw its influence. Attributory text mentions of herbal medicine which found their way into China and traditional Persian medicine recognized turmeric as possessing healing qualities chiefly among physicians arguing for its anti-inflammatory value and being antidigestive. In Unani medicine, among other ancient Greco-Arabic natural healing modalities, turmeric was widely valued for the treatment of liver and digestive problems, further cementing its usage within Asian and Middle Eastern healing {treatments} respectively.

The western world came In contact with turmeric through Arab trading; however, its active substances made their way into 18th-century European science. In 1815 came the watershed moment when Vogel and Pelletier isolated curcumin as the principal pigment in turmeric. By 1910, the structure of curcumin had already been explained, and attempts to evaluate its activity en masse began.

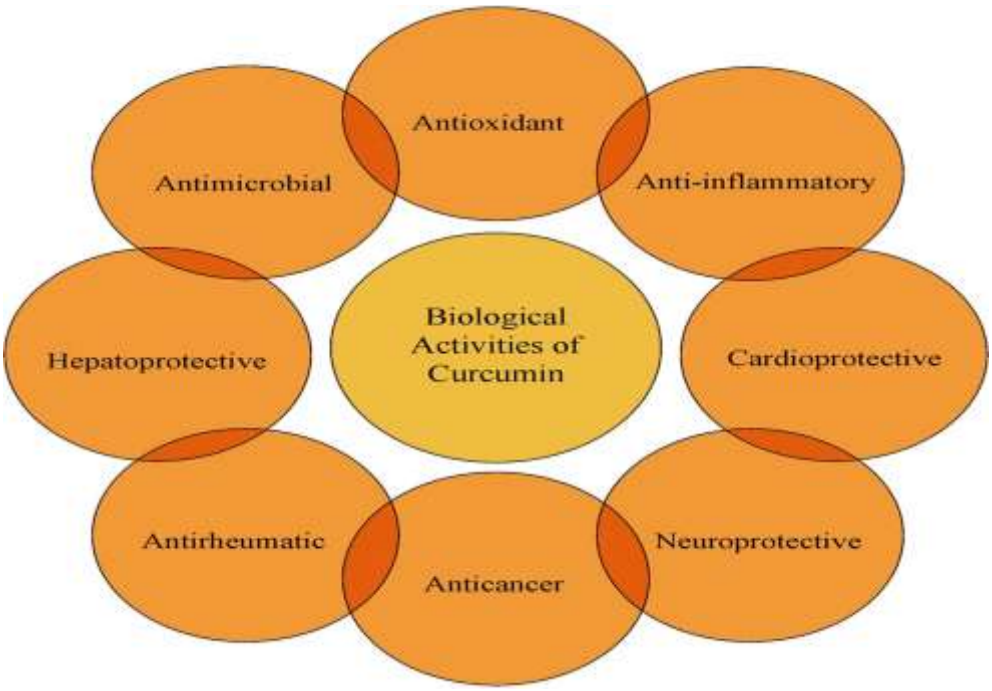
But that scientific interest did not lead to substantial research on the potential of curcumin until the late 20th century. More interest came on the scene through natural products and traditional medicine, causing curcumin to spur extensive clinical and laboratory studies. In the late 20th and early 21st centuries, curcumin was determined to have remarkable antioxidant, anti-inflammatory and anticancer properties, which was the impetus for further investigations. Together with these recent developments, curcumin has become one of the most widely studied plant-derived compounds in biomedical research. This marvelous chronicle in history shows curcumin's value in carrying forward ancient medicine to modern therapeutic science.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

III. CURCUMIN ON HEALTH PROMOTION AND DISEASE PREVENTION

Various biological effects for the promotion of health and disease prevention have long been ascribed to curcumin and its derivatives.

The major countries that have contributed to the scientific advances in curcumin bioactive effects are the United States, China, India, Japan, and South Korea, with the most concentrated study being on their anticancer, pro-inflammatory, and antioxidant potential. The pre-clinical and clinical data related to curcumin bioactive effects are briefly discussed in the subsequent sections, as well as an explanation of the respective mode of action.



Anti-oxidant activity

Curcumin is a natural polyphenolic compound, the primary bioactive component of turmeric (Curcuma longa), which has been the focus of intense interest due to its powerful antioxidant properties. Its phenolic groups and enol form contribute to its antioxidant effects through the donation of hydrogen atoms and quenching of reactive oxygen species (ROS), which ultimately results in several antioxidant effects. Curcumin can scavenge various radicals, including superoxide anions, hydrogen peroxide, peroxyl, hydroxyl, peroxynitrite, and singlet oxygen radicals, and thus provides a broad spectrum of antioxidant properties. Significantly, studies have also suggested that curcumin has an antioxidant effect that is comparable to the non-enzymatic antioxidants such as ascorbic acid (vitamin C) and alpha-tocopherol (vitamin E), reinforcing its antioxidant potential . In addition to its direct scavenging activity, curcumin can activate endogenous antioxidant enzymes such as superoxide dismutase (SOD), catalase, and glutathione peroxidase. This ability allows curcumin to modulate both immediate and adaptation phase antioxidant defense mechanisms, making it an ideal candidate for a variety of pathologies induced by oxidative stress. Due to its many beneficial antioxidant effects, curcumin has been investigated for potential therapeutic benefits in conditions associated with increased oxidative stress and ROS production, including cardiovascular diseases, neurodegenerative disorders, and cancer .

Anti-inflammatory activity

Curcumin, an active polyphenolic compound derived from Curcuma longa (turmeric), is well-known for its powerful anti-inflammatory properties. Its ability to modulate an array of signaling molecules active in inflammation has been proven: It will primarily inhibit nuclear factor kappa B (NF-κB), a significant transcription factor in the adjustment of pro-inflammatory chemokines, cytokines and adhesion molecules. Curcumin also inhibits cyclooxygenase-2 (COX-2) responsible for the synthesis of prostaglandins that are crucial for inflammatory responses.

e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:11/November-2024 Impact Factor- 8.187 www.irjmets.com

Curcumin operates through various other molecular targets besides inhibiting NF-κB and COX-2, leading to reduced oxidative stress and inflammation: these include, but are not limited to, MAPKs, TNF-α, ILs, and ROS, the last of which confers devastating damages to biomolecules. Antioxidant activity allows it to extend its anti-inflammatory effect via free radical scavenging.

The remarkably versatile actions of the compound emerge as Immediate possibilities to manage a myriad of inflammatory disorders, including arthritis, cardiovascular disorders, and inflammatory bowel diseases (IBD).

Anti-Cancer Activity

Curcumin, a bioactive compound obtained from Curcuma longa (turmeric), has reported significant antitumor effect in different types of cancers. The possibility lies in its capacity to modulate multiple molecular targets and pathways involved in cancer-progressing activities. The effects of curcumin include inhibiting proliferation, inducing apoptosis of malignant cells, and suppression of angiogenesis, modulating the immune response.

One major mode of action of curcumin involves reducing transcription factors such as NF-kappa B and AP-1 that are involved in cell survival and inflammation. Curcumin downregulates these transcription factors and thus suppresses the expression of anti-apoptotic proteins like Bcl-2 and Bcl-xL, facilitating programmed cell death in neoplastic cells. Furthermore, it acts toward inhibiting the PI3K/Akt and MAPK pathways that are important for cell proliferation as well as survival. In addition, curcumin has been shown to inhibit angiogenesis by downregulating VEGF and other pro-angiogenic factors, restraining the tumor from growing and metastasizing.

Low toxicity and anticancer activity of curcumin make it a great candidate in cancer therapy

Mechanism of Action (MOA)	Pathway Targeted	Outcome in Cancer cells
Inhibition of transcription factor	NF-kB AP-1	Deceased anti apoptic proteins (Bcl-2,Bcl-xl) leading cell apoptosis
Inhibition of growth pathways	P13/Akt, MAPk	Reduced Cell Growth and survival
Suppression of Angiogenesis	VEGF and other Pto-angiogenic factors	Inhibited tumour growth and metastasis

Cardioprotective Activity

In this respect, curcumin represents a potent cardioprotective agent, which has been substantiated by a plethora of studies. These potential benefits of curcumin may be attributed, in large part, to its ability to function as an antioxidant, anti-inflammatory, antihyperlipidemic agent, and finally confer a tonic effect..

Curcumin can be more widely accepted in the therapeutic arsenal of CVD as it plays a significant role in combating oxidative stress and inflammation, two contributors to the risk of CVD. Such activity is mediated through alternative mediatory pathways like NF-κB, which modulates inflammatory responses. Furthermore, curcumin helps minimize oxidative damage to the cardiac tissue by inhibiting NF-κB and upregulating antioxidant enzymes like SOD. By favorably affecting the PI3K/AKT and AMPK pathways, curcumin supports the survival and integrity of cardiac cells while at the same time reducing apoptosis and thus protects myocardial tissue under conditions of stress.

Besides, curcumin modulates lipid metabolism by acting on certain enzymes involved in the biosynthesis of cholesterol and triglycerides and lowers their serum levels. It also helps in enhancing the function of the endothelial cell, which acts as a protective factor in the formation of atheromatous plaques.

Curcumin therefore proves to be one of the most promising add-on therapies for the management of CVD.

IV. REFERENCES

[1] Anand, P., Sundaram, C., Jhurani, S., et al. (2008). Curcumin and cancer: An “old-age” disease with an “age-old” solution. Cancer Letters, 267(1), 133-142.

[2] Zhang, Z., & Tang, M. (2017). Curcumin as a therapeutic drug for Alzheimer’s disease. Journal of Alzheimer’s Disease, 58 (2), 409-417.

[3] Jiang, H., & Wang, W. (2019). Curcumin's therapeutic effects on cardiovascular diseases: Insights into its mechanisms. Nutritional Journal, 18(1), 4-10.
[4] Koehn, F. E., & Carter, G. T. (2005). The evolving role of natural products in drug discovery. Nature Reviews Drug Discovery, 4(3), 206-220.
[5] Sharma, R. A., McLelland, H. R., et al. (2005). Pharmacodynamic and pharmacokinetic studies of curcumin in cancer patients. Cancer Chemotherapy and Pharmacology, 56(1), 115-122
[6] Kumari, P., & Bhardwaj, K. (2020). Curcumin nanocarriers: Emerging strategies for enhanced bioavailability and therapeutic applications. Nanomedicine: Nanotechnology, Biology, and Medicine, 22(5), 171-187.
[7] Anand, P., Sundaram, C., Jhurani, S., et al. (2008). Curcumin and cancer: An "old-age" disease with an "age-old" solution. Cancer Letters, 267(1), 133-142.
[8] Sharma, R. A., McLelland, H. R., et al. (2005). Pharmacodynamic and pharmacokinetic studies of curcumin in cancer patients. Cancer Chemotherapy and Pharmacology, 56(1), 115-122.
[9] Zhang, Z., & Tang, M. (2017). Curcumin as a therapeutic drug for Alzheimer's disease. Journal of Alzheimer's Disease, 58(2), 409-417.
[10] Koehn, F. E., & Carter, G. T. (2005). The evolving role of natural products in drug discovery. Nature Reviews Drug Discovery, 4(3), 206-220.
[11] Jiang, H., & Wang, W. (2019). Curcumin's therapeutic effects on cardiovascular diseases: Insights into its mechanisms. Nutritional Journal, 18(1), 4-10.
[12] Prasad S, Gupta SC, Tyagi AK, Aggarwal BB. "Curcumin, a component of golden spice: From bedside to bench and back." Biotechnology Advances. 2014;32(6):1053-1064.
[13] Aggarwal BB, Yuan W, Li S, Gupta SC. "Curcumin-free turmeric exhibits anti-inflammatory and anticancer activities: Identification of novel components of turmeric." Molecular Nutrition & Food Research. 2013;57(9):1529-1542.
[14] Jurenka JS. "Anti-inflammatory properties of curcumin, a major constituent of Curcuma longa: A review of preclinical and clinical research." Alternative Medicine Review. 2009;14(2):141-153.
[15] Ammon HP, Wahl MA. "Pharmacology of Curcuma longa." Planta Medica. 1991;57(1):1-7.
[16] 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.
[17] Menon, V. P., & Sudheer, A. R. (2007). Antioxidant and anti-inflammatory properties of curcumin. Advances in Experimental Medicine and Biology, 595, 105-125.
[18] Ak, T., & Gulcin, I. (2008). Antioxidant and radical scavenging properties of curcumin. Chemico-Biological Interactions, 174(1), 27-37.
[19] Gupta, S. C., Patchva, S., & Aggarwal, B. B. (2013). Therapeutic roles of curcumin: lessons learned from clinical trials. AAPS Journal, 15(1), 195-218.
[20] Sharma, R. A., Gescher, A. J., & Steward, W. P. (2005). Curcumin: the story so far. European Journal of Cancer, 41(13), 1955-1968.
[21] Gupta, S. C., et al. (2013). "Curcumin, a component of turmeric: from farm to pharmacy." Biofactors, 39(1), 8-13. Doi:10.1002/biof.1004.
[22] Goel, A., et al. (2008). "Curcumin as 'Curecumin': From kitchen to clinic." Biochemical Pharmacology, 75(4), 787–809.
[23] Kunnumakkara, A.B., et al. (2017). "Curcumin, the golden nutraceutical: multitargeting for multiple chronic diseases." British Journal of Pharmacology, 174(11), 1325–1348.
[24] Panahi, Y., et al. (2012). "Effect of curcuminoids on oxidative stress and inflammation in myocardial infarction: A review." Journal of Pharmacology & Pharmacotherapeutics, 3(1), 58–64.
[25] Meng, Z., et al. (2019). "Cardioprotective effects and mechanisms of curcumin in CVD: Focus on cellular pathways." Journal of Molecular Medicine, 97(1), 33–45.