Content available at: https://www.ipinnovative.com/open-access-journals

Current Trends in Pharmacy and Pharmaceutical Chemistry

Journal homepage: https://www.ctppc.org/

Review Article

Ethnopharmacological review of turmeric for anticancer activity

Amit Gajanan Nerkar[1,2,3,*], **Rushikesh Nagarkar**[1], **Shubhangi Badar**[1]

[1]*Dept. of Pharmacy, CAYMET's Siddhant College of Pharmacy, Sudumbare, Pune, Maharashtra, India*
[2]*Ateos Foundation of Science Education and Research, Pune, Maharashtra, India*
[3]*Carolene Therapeutics, Pvt. Ltd, Aurangabad, Maharashtra, India*

ARTICLE INFO

Article history:
Received 20-02-2023
Accepted 10-03-2023
Available online 04-04-2023

Keywords:
Turmeric
Curcumin Linn
Anticancer
Ethnopharmacology
Pharmacology
Pharmacognosy

ABSTRACT

These reviews suggest that in the Indian subcontinent, turmeric (Curcuma longa Linn) is widely grown and consumed as a spice. Traditional medicine has used turmeric to treat a variety of ailments, such as diabetes, liver disease, and cough. Many studies have been conducted over the past decades to determine the pharmacological effects of turmeric and its derivatives. The main chemical component of turmeric, curcumin, has been shown to have pharmacological properties including anti-inflammatory, antioxidant, anti-mutagenic, antidiabetic, and antibacterial properties., protect liver, expectorant and anti-cancer. Turmeric, also known as Curcuma longa L. (root and rhizome), is a plant of high medicinal and commercial value, mainly used as a spice and food supplement around the world. The three curcuminoids - curcumin (diferuloylmethane, the main ingredient that gives turmeric its yellow color), demethoxycurcumin, and bisdemethoxycurcumin - are the main active ingredients of turmeric. Volatile oils (zingiberene, atlantone, tomerol, etc.) also have pharmacological effects. In addition, turmeric contains proteins, resins and carbohydrates. Turmeric is a powerful antioxidant and has significant anti-inflammatory properties. Turmeric's anti-inflammatory properties may be directly related to its anti-cancer properties. In this review, the anticancer properties of Turmeric have been reviewed.

1. Introduction

Turmeric, or Curcuma longa Lin.,[1] belongs to the Zingiberaceae plant family. The plant has a lot of potential in terms of medicinal properties.[2,3] It has a number of beneficial qualities including those of anti-inflammatory, biliary, hepatoprotective, blood purifier, antioxidan t, detoxifying and regenerating liver tissue, anti-asthmatic, anti-cancer, anti-toxin, digestion and carminative, as noted in the literature.[4–9] Plasma cholesterol levels can be lowered using curcumin. The heart and arteries are preserved by its antiplatelet activity. It also protects against DNA damage in lymphocytes.[10] The parts of this plant contain curcumin, a type of flavonoid. About 60-70% of turmeric powder is made up of carbohydrates, while other ingredients include 6-8% protein, 5-8%, 3-7% minerals, 3-7% essential oils, 2-7% fiber[11] and 1-6% curcuminoids. The phytochemicals in turmeric are found in Diarylheptanoids, a different group of curcuminoids that includes curcumin, demethoxycurcumin, and bisdemethoxycurcumin.[12] It was also observed that Zingiber officinale Roscoe and Curcuma longa Linnaeus are the two main species of Zingiberaceae studied for a variety of pharmaceuticals, including anti-inflammatory, anti-angiogenic, antibacterial, analgesic, immunomodulatory, pro-apoptotic, anti-HIV and anti-cancer.[13] Further some researchers also found that the Curcumin is a polyphenol natural product isolated from turmeric, interacting with different cellular and molecular targets and, consequently,

* *Corresponding author*.
E-mail address: dragnerkar@gmail.com (A. G. Nerkar).

https://doi.org/10.18231/j.ctppc.2023.003

showing a wide range of pharmacological effects.[14] Taxanomical Classification.

1. Kingdom: Plantae
2. Subkingdom: Tracheobionta
3. Super division: Spermatophyta
4. Division: Magnoliophyta
5. Subclass: Zingiberidae
6. Order: Zingiberales
7. Family: Zingiberaceae
8. Genus: Curcuma
9. Species: longa
10. Scientific name: Curcuma longa

1.1. Geographical distribution[15]

1. *World scenario:* It is commonly found in Cambodia, China, India, Nepal, Indonesia, Madagascar, Malaysia, Philippines and Viet Nam.
2. *India scenario:* It is commonly found in West Bengal, Tamil Nadu, and Maharashtra and also in Madras.
3. *History:* In the year the Vedic civilization of India, it was used as a culinary spice and has some religious significance, turmeric has been used for about 4000 years. By AD 700, it could have spread to China, East Africa, West Africa, and Jamaica. In 1200 AD, it may have reached China. Marco Polo wrote about this spice in 1280, showing a vegetable very close in character to saffron. Turmeric has a long history of medicinal use in South Asia, according to Sanskrit medical texts, Ayurvedic and Unani traditions. An ointment containing turmeric is suggested in the Ayurvedic compendium of Sushruta, dating back to 250 BC. In AD, it was used to treat the effects of contaminated food.[16]

1.2. Cultivation[16,17]

1. *Climate:* For proper growth, the turmeric plant requires temperatures between 20°C and 30°C as well as a good amount of annual rainfall. Individual plants have long, oblong leaves and can reach a height of 1 m. Both the tropics and the subtropics are suitable for growing the tropical herb turmeric. If the shade is not too dense, it will grow lushly, but on open land that is exposed to the light, it generates bigger and better rhizomes. Turmeric needs a humid environment.
2. *Soil:* The soil should be rich and friable while growing turmeric. Suitable soils have a slightly higher sand content. It is grown in a variety of soil types, from clay loams to light black, sandy loam, and red soils. It thrives in irrigated and rain-fed locations on light black, ashy loam, red soils, and stiff loams.
3. *Harvesting:* Typically, the harvest season is from January until March or April. Early and medium varieties reach maturity in 7-8 and 8-9 months, respectively. The crop is ready to be cut when the leaves begin to dry out and turn yellow. When the plant reaches maturity, the leaves are removed just above the soil, the earth is tilled, and rhizomes are collected by hand plucking or by carefully lifting the clumps with a spade.
4. *Irrigation:* The amount of irrigations for turmeric will depend on the soil and weather. In medium-heavy soils, 15 to 25 irrigations are supplied, while in red soils with a light texture, 35 to 40 irrigations are required. Rhizomes for seed are typically piled up and covered with turmeric leaves under trees or in sheds with good ventilation. The seed rhizomes can also be kept in sawdust-filled pits.

1.3. Health benefits/Uses1[1,9–20]

1. Turmeric promotes balanced mood.
2. Turmeric helps wounds healing.
3. Turmeric group seemed to enjoy more relief from joint pain.
4. Turmeric helps in balanced blood sugar
5. Leprosy, dysentery, heart disease, jaundice, diabetes, lactation antimicrobials, and antioxidants.
6. They have been used for rheumatism, diabetes, stomach ulcers, hepatic disorders, boils, skin conditions, enlarged liver, spleen, and chest pain, among other traditional medical conditions.
7. Older research indicates that curcumin has antimicrobial, anti-inflammatory, dyspepsia and gastric ulcer, irritable bowel syndrome, pancreatitis, rheumatoid arthritis, osteoarthritis, and antioxidant properties.
8. It is also the primary active component of all curcuma plants and is responsible for the yellow colour of curcuma.

1.4. Side effects, contraindications and precautions[21–25]

1. The patient facing gall bladder is recommended not to eat turmeric.
2. If any patient had bleeding problems, it is recommended to steer clear of turmeric.
3. High doses of turmeric cause uterine contraction in pregnant women.
4. Turmeric might lower testosterone levels and decrease sperm movement when taken by mouth by men.
5. Turmeric might slow blood clotting so stop using it at least two weeks before a scheduled surgery.
6. Taking high amounts of turmeric might prevent the absorption of iron. So it should be used with caution in people with iron deficiency.

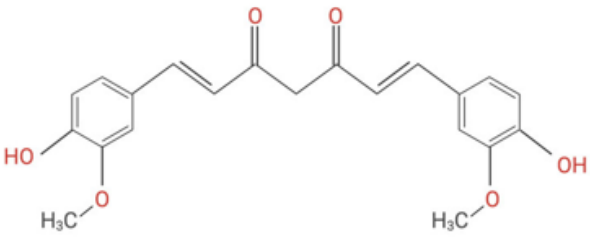

Fig. 1: Curcumin

2. Chemical Constituents of Turmeric[26–28]

The active constituent of Turmeric is shown in the figure viz Curcumin. Further the following are the active constituents of Turmeric, in a standard form, turmeric contains moisture (>9%), curcumin (5–6.6%), extraneous matter (<0.5% by weight), mould (<3%), and volatile oils (<3.5%). Volatile oils include d-α-phellandrene, d-sabinene, cinol, borneol, zingiberene, and sesquiterpenes). The active constituents of turmeric are shown in Figure below. Curcumin, the active ingredient in the Curcuma longa plant, has received a lot of attention over the past two decades as an antioxidant, anti-inflammatory, and anti-cancer agent. In this review, a summary of the pharmacochemistry and pharmacology of curcumin and its derivatives for their antitumor activity, their main mechanisms of action, and cellular targets has been provided based on Data from the literature from experimental and clinical reviews of curcumin in cancer cell lines, animal models and human subjects showed promising results.

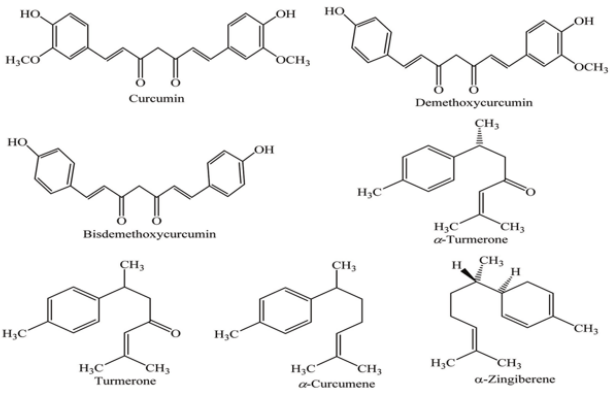

Fig. 2: Active constituents of Turmeric

3. Review for Anticancer Activity of Turmeric

Through its effects on several biological pathways involved in mutation, oncogene expression, cell cycle regulation, apoptosis, tumorigenesis, and metastasis, curcumin has been proven to have anti-cancer properties. Curcumin inhibits NF-B transcription factor and downstream gene products, and has demonstrated anti-proliferative effects in several malignancies (including c-myc, Bcl-2, COX-2, NOS). , Cyclin D1,[29] TNF-α,[30] interleukin and MMP-9). Various growth factor receptors and cell adhesion molecules involved in tumor growth, angiogenesis, and metastasis are also affected by curcumin. By modifying the deregulated cell cycle by,

1. Cyclin-dependent[31]
2. p53-dependent and[32]

Curcumin demonstrates its anti-tumor effects in cancer cells. Because of its effects on key cell cycle signaling pathways and its success in animal model systems, curcumin has been recognized as a multifaceted weapon in the fight against cancer.[33] deadly cancer. Natural phytochemicals such as curcumin could connect to these new targets and synergize with chemotherapy. Curcumin is also well tolerated in humans. Therefore, potential targets and procedures in the treatment of lung cancer could include EGFR-miRNA autophagy and cancer stem cell therapy in the presence of curcumin. Curcumin exerts its anticancer activity through multiple mechanisms, interfering with various cellular pathways and inducing the production of a variety of cytokines, enzymes or growth factors such as MAPK, EGF, NFκB.[34] PKD1, COX-2, STAT3, TNF-α and IκKβ. Treatment with curcumin simultaneously reduced anticancer drug IC50 and stem cell counts. Also it was found to be good for treated breast cancer cell lines MBA-MB-231 and MCF-7 with paclitaxel, cisplatin or doxorubicin alone or in combination with curcumin or other natural compounds. Chemotherapy drugs reduce survival and curcamine reduces IC50 of experimental cell lines.[35–38] In a research on turmeric it was also demonstrated that curcumin reduced chemo resistance while increasing chemosensitivity of tumor cells. The law of Bcl-2-mediated apoptosis, including the PI3K and Wnt signaling pathways, may be the basis for these effects. The convenience of the Bcl-2 protein is an important factor for the development of drug resistance. By combining with other apoptosis-related proteins, Bcl-2 inhibits the tumor suppressor effects of drugs and promotes drug resistance.[39] Anti-cancer activity of turmeric against a variety of human cancers. The anticancer mechanism of curcumin involves the regulation of multiple signaling pathways. Numerous experiments have demonstrated that curcumin can modulate the Wnt/β-catenin, PI3K/Akt, JAK/STAT, MAPK, p53 and NF-κB signaling pathways in cancer cells.[40] Curcumin also possesses apoptotic and autophagic pathways. Curcumin may show the development of chemoresistance due to its multitarget activity in cancer. The effects of curcumin were studied in a dose-responsive experiment. The proliferation

of MCF7 cells was significantly inhibited by curcumin in a concentration-dependent manner for 48 h ($P < 0.01$). Different concentrations of curcumin after 48 h had different cytotoxic effects on the MCF7 cell line.[41]

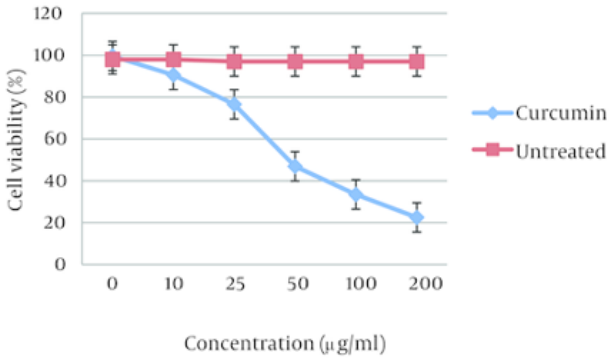

Fig. 3: Concentration

It has been proven that cancer is the second leading cause of death in the world and one of the major public health problems. With great advances in cancer treatment, cancer morbidity and mortality rates remain high. The search for more effective and less toxic cancer treatment strategies is at the forefront of current research[42–46] The research in this regard, the effects of numerous common fruit, herb, and vegetable extracts on the in vitro viability of two human ovary cancer cell lines (SKOV-3 and PEO1) were investigated.[43] In another research turmeric was evaluated the in vitro anti-tumor potential (human thyroid cancer cell line) of curcumin and elucidated its molecular mechanism. Here, we investigated the effects of curcumin on cell viability, apoptosis, migration and invasion of the human thyroid cancer cell lines FTC133. Polyphenols and other natural substances have been found by Kashifa et.al from turmeric have the ability to affect cancer cells without causing negative side effects.[47] They increase chemosensitivity, have higher absorption capacity, and can combat and reduce multidrug resistance. Neuroprotective effects of demethoxycurcumin, a natural derivative of curcumin on neurotoxicity induced by rotenone in the cells of SH-SY 5Y neuroblastoma have been found positive.[48] T. Liu et al. found that human CD44+/CD133+ prostate cancer stem cells (HuPCaSC) were isolated from the prostate cancer cell lines Du145 and 22RV1,[49,50] Curcumin treatment of these cells resulted in inhibition of proliferation and invasion in vitro and cell cycle arrest.[51] Turmeric oil and curcumin, derived from Curcuma Longa.[52–54]

4. Conclusion

Curcumin has been recognized as a complex weapon in the fight against cancer, a deadly disease, due to its effects on key cell cycle signaling pathways and its effectiveness in animal model systems. Curcumin is a natural phytochemical that can interact with these new targets and aid chemotherapy. A wide range of important chemicals, including starches, proteins, vitamins, volatile oils and the main components of curcumin and curcuminoids, have been identified through phytochemical research on turmeric. These compounds have been shown to have many potent pharmacological properties. This review renews the impetus for the use of turmeric as a treatment and prevention approach of cancer.

5. Source of Funding

None.

6. Conflict of Interest

None.

7. Acknowledgment

The Authors RPN and SB thank the Author, and their UG Supervisor AGN for his genuine support. The Author AGN acknowledges Shri R. S.Yadav, President, CAYMET and Dr. R.K. Dumbre of CAYMET's Siddhant College of Pharmacy for their due moral support.

References

1. Chanda S, Ramachandra TV. Phytochemical and pharmacological importance of turmeric (Curcuma longa): A review. *Res Rev A J Pharmacol*. 2019;9(1):16–23.
2. Verma RK, Kumari P, Maurya RK, Kumar V, Verma RB, Singh RK. Medicinal properties of turmeric (Curcuma longa L.): A review. *Int J Chem Stud*. 2018;6(4):1354–61.
3. Nasri H, Sahinfard N, Rafieian M, Rafieian S, Shirzad M, Kopaei MR. Turmeric: A spice with multifunctional medicinal properties. *J Herb Med Pharmaco*. 2014;3(1):5–8.
4. Akram M, Shahab-Uddin AA, Usmanghani KH, Hannan AB, Mohiuddin E, Asif M. Curcuma longa and curcumin: a review article. *Rom J Biol Plant Biol*. 2010;55(2):65–70.
5. Wonkchalee O, Boonmars T, Aromdee C, Laummaunwai P, Khunkitti W, Vaeteewoottacharn K. Anti-inflammatory, antioxidant and hepatoprotective effects of Thunbergia laurifolia Linn. on experimental opisthorchiasis. *Parasitol Res*. 2012;111(1):353–62.
6. Nabavi SF, Daglia M, Moghaddam AH, Habtemariam S, Nabavi SM. Curcumin and Liver Disease: from Chemistry to Medicine. *Compr Rev Food Sci Food Saf*. 2014;13(1):62–77.
7. Labban L. Medicinal and pharmacological properties of Turmeric (Curcuma longa): A review. *Int J Pharm Biomed Sci*. 2014;5(1):17–23.
8. Hashish EA, Elgaml SA. Hepatoprotective and Nephroprotective Effect of Curcumin Against Copper Toxicity in Rats. *Indian J Clin Biochem*. 2016;31(3):270–7.
9. Kuttan R, Bhanumathy P, Nirmala K, George MC. Potential anticancer activity of turmeric (Curcuma longa). *Cancer lett*. 1985;29(2):197–202.
10. Razavi BM, Rahbardar G, Hosseinzadeh M. A review of therapeutic potentials of turmeric (Curcuma longa) and its active constituent, curcumin, on inflammatory disorders, pain, and their related patents. *Phytother Res*. 2021;35(12):6489–513.
11. Jayaprakasha GK, Rao JM, Sakariah L. Improved HPLC method for the determination of curcumin, demethoxycurcumin, and bisdemethoxycurcumin. *J Agricul Food Chem*. 2002;50(13):3668–72.

12. Jiang H, Timmermann BN, Gang DR. Use of liquid chromatography-electrospray ionization tandem mass spectrometry to identify diarylheptanoids in turmeric (Curcuma longa L.) rhizome. *J Chromatography* . 2006;1111(1):21–31.
13. Farida WR, Shidiq F, Inayah N, Handayani TH. Effect of turmeric (Curcuma longa Linnaeus) and ginger (Zingiber officinale Roscoe) powder in feed on nutrient digestibility and performance of sunda porcupine. *InIOP Conf Series: Earth Environ Sci*. 2021;788(1):12056.
14. Momtazi-Borojeni AA, Abdollahi E, Nikfar B, Chaichian S, Hundrieser ME. Curcumin as a potential modulator of M1 and M2 macrophages: new insights in atherosclerosis therapy. *Heart Failure Rev*. 2019;24(3):399–409.
15. Yadav RP, Tarun G, Roshan C, Yadav P. Versatility of turmeric: A review the golden spice of life. *J Pharmacogn Phytochem*. 2017;6(1):4–7.
16. Nair KP. Turmeric: origin and history. InTurmeric (Curcuma longa L.) and Ginger (Zingiber officinale Rosc.)-World's Invaluable Medicinal Spices. Springer; 2019. p. 1–6.
17. Chen WL, Lin YB, Lin YW, Chen R, Liao JK, Ng FL. AgriTalk: IoT for precision soil farming of turmeric cultivation. *IEEE Internet of Things J*. 2019;13(3):5209–32.
18. Singletary K. Turmeric: an overview of potential health benefits. *Nutrition Today*. 2010;45(5):216–41.
19. Singletary K. Turmeric: potential health benefits. . *Nutrition Today*. 2020;55(1):45–56.
20. Hay E, Lucariello A, Contieri M, Esposito T, Luca D, Guerra A. Therapeutic effects of turmeric in several diseases: An overview. *Chemico Biol Interact*. 2019;310(1):108729. doi:10.1016/j.cbi.2019.108729.
21. Hassan A. Curcuma longa, turmeric: a monograph. *Aust J Med Herbalism*. 2006;18(2):66–76.
22. Asher GN, Spelman K. Clinical utility of curcumin extract. . *Altern Ther Health Med*. 2013;19(2):14–6.
23. Waghmare PR, Kakade PG, Takdhat PL, Nagrale AM, Thakare SM, Parate MM. Turmeric as medicinal plant for the treatment of acne vulgaris. *PharmaTutor*. 2017;5(4):19–27.
24. Dejonckheere V. Turmeric for Osteoarthritis in Veterinary Medicine: a Review. . *Veterinary Chiropractic Care, Acupuncture and Herbal Medicine*. 2016;p. 1–16.
25. Anushri M, Yashoda R, Puranik MP. Herbs: A good alternatives to current treatments for oral health problems. dermatitis (from topical application). *Int J Adv Health Sci*. 2015;1(12):9–12.
26. Labban L. Medicinal and pharmacological properties of Turmeric (Curcuma longa): A review. *Int J Pharm Biomed Sci*. 2014;5(1):17–23.
27. Kuttan R, Bhanumathy P, Nirmala K, George MC. Potential anticancer activity of turmeric (Curcuma longa). . *Cancer lett*. 1985;29(2):197–202.
28. Khanna NM. Turmeric-Nature's precious gift. . *Curr Sci*. 1999;76:1351–7.
29. De Porras V, Bystrup S, Cardus AM, Ginés A, Layos L, Manzano JL. Curcumin mediates oxaliplatin-acquired resistance reversion in colorectal cancer cell lines through modulation of CXC-Chemokine/NF-κB signalling pathway. *Cancer Res*. 2015;75:5478.
30. Aggarwal BB, Banerjee S, Bharadwaj U, Sung B, Shishodia S, Sethi G. Curcumin induces the degradation of cyclin E expression through ubiquitin-dependent pathway and up-regulates cyclin-dependent kinase inhibitors p21 and p27 in multiple human tumor cell lines. *Biochem Pharmacol*. 2007;73(7):1024–32.
31. Srivastava RK, Chen Q, Siddiqui I, Sarva K, Shankar S. Linkage of curcumin-induced cell cycle arrest and apoptosis by cyclin-dependent kinase inhibitor p21(/WAF1/CIP1). *Cell Cycle*. 2007;6(23):2953–61.
32. Meeran SM, Katiyar SK. Cell cycle control as a basis for cancer chemoprevention through dietary agents. *Cell cycle control as a basis for cancer chemoprevention through dietary agents*. 2008;13:2191–202. doi:10.2741/2834.
33. Singh DB, Maurya AK, Rai D. Science of Spices and Culinary Herbs - Latest Laboratory, Pre-clinical, and Clinical Studies. In: Antibacterial and anticancer activities of turmeric and its active ingredient curcumin, and mechanism of action. vol. 1. Sharjah, UAE: Bentham Science Publishers; 2019. p. 74–103.
34. Sumirtanurdin R, Sungkar S, Hisprastin Y, Sidharta KD, Nurhikmah DD. Molecular docking simulation studies of curcumin and its derivatives as cyclin-dependent kinase 2 inhibitors. *Turkish J Pharm Sci*. 2020;17(4):417–23.
35. Lai HW, Chien SY, Kuo SJ, Tseng LM, Lin HY, Chi CW. The potential utility of curcumin in the treatment of HER-2-overexpressed breast cancer: an in vitro and in vivo comparison study with herceptin. *Evid Based Complement Altern Med*. 2012;17(4):471–23.
36. Shehzad A, Lee YS. Molecular mechanisms of curcumin action: signal transduction. *Biofactors*. 2013;39(1):27–36.
37. Ye J, Piao H, Jiang J, Zheng JG, Yang M. Polydatin inhibits mast cell-mediated allergic inflammation by targeting PI3K/Akt, MAPK, NF-κB and Nrf2/HO-1 pathways. *Sci Rep*. 2017;7(1):1–3.
38. Guo X, Ding X. Dioscin suppresses the viability of ovarian cancer cells by regulating the VEGFR2 and PI3K/AKT/MAPK signaling pathways. *Oncol Lett*. 2018;15(6):9537–79.
39. Zarqa MAAS. Could the cancer be a chronic immune disorder? rather than a serious malignant disease. *Der Pharma Chem*. 2014;6(2):140–8.
40. Lin JK. Suppression of protein kinase C and nuclear oncogene expression as possible action mechanisms of cancer chemoprevention by Curcumin. *Arc Pharmacal Res*. 2004;27(7):683–92.
41. Simon A, Allais DP, Duroux JL, Basly JP, Fontanier SD, Delage C. Inhibitory effect of curcuminoids on MCF-7 cell proliferation and structure-activity relationships. *Cancer lett*. 1998;3(1):111–7.
42. Kuttan R, Bhanumathy P, Nirmala K, George MC. Potential anticancer activity of turmeric (Curcuma longa). *Cancer lett*. 1985;29(2):197–202.
43. Nair A, Amalraj A, Jacob J, Kunnumakkara AB, Gopi S. Non-curcuminoids from turmeric and their potential in cancer therapy and anticancer drug delivery formulations. *Biomolecules*. 2019;9(1):13. doi:10.3390/biom9010013.
44. Shukla DP, Shah KP, Rawal RM, Jain NK. Anticancer and cytotoxic potential of turmeric (Curcuma longa), neem (Azadirachta indica), tulasi (Ocimum sanctum) and ginger (Zingiber officinale) extracts on HeLa cell line. *Int J Life Sci Sci Res*. 2016;2:309–24.
45. Vemuri SK, Banala RR, Subbaiah GP, Srivastava SK, Reddy AG, Malarvili T. Anti-cancer potential of a mix of natural extracts of turmeric, ginger and garlic: A cell-based study. *Egyptian J Basic Appl Sci*. 2017;4(4):332–76.
46. Thanki K, Gangwal RP, Sangamwar AT, Jain S. Oral delivery of anticancer drugs: challenges and opportunities. *J Controlled Rel*. 2013;170(1):15–40.
47. Fathima K, Lavanya J, Jamal V, Ahmed S. The Effectiveness of Various Chemotherapeutic Agents in Cancer Treatment. *Curr Pharmacol Rep*. 2022;23:1–7.
48. Meo D, Margarucci F, Galderisi S, Crispi U, Peluso S. Curcumin, gut microbiota, and neuroprotection. *Nutrients*. 2019;11(10):2426–6.
49. Wei MM, Zhao SJ, Dong XM, Wang YJ, Fang C, Wu P. A combination index and glycoproteomics-based approach revealed synergistic anticancer effects of curcuminoids of turmeric against prostate cancer PC3 cells. *J Ethnopharmacol*. 2021;267:113467. doi:10.1016/j.jep.2020.113467.
50. Chaudhary LR, Hruska KA. Inhibition of cell survival signal protein kinase B/Akt by curcumin in human prostate cancer cells. *J Cell Biochem*. 2003;89(1):1–5.
51. Sha J, Li J, Wang W, Pan L, Cheng J, Li L. Curcumin induces G0/G1 arrest and apoptosis in hormone independent prostate cancer DU-145 cells by down regulating Notch signaling. *Biomed Pharmacother*. 2016;84:177–84. doi:10.1016/j.biopha.2016.09.037.
52. Jacob JN, Toloue M. Biological studies of turmeric oil, Part 1: Selective in vitro anticancer activity of turmeric oil (TO) and TO-paclitaxel combination. *Nat Prod Commun*. 2013;8(6):1934578.
53. Hamidpour R, Hamidpour S, Hamidpour M, Sohraby M, Hamidpour M. Curcuma longa): from a variety of traditional medicinal applications to its novel roles as active antioxidant, anti-inflammatory, anti-cancer, and anti-diabetes. *Int J Pharmacol Phytochem Ethnomed*.

2015;1(1):37–45.
54. Ahmad R, Srivastava AN, Khan MA. Evaluation of in vitro anticancer activity of rhizome of Curcuma longa against human breast cancer and Vero cell lines. *Evaluation*. 2016;1(1):1–6.

Author biography

Amit Gajanan Nerkar, Professor and Research Head
https://orcid.org/0000-0002-1377-8466

Rushikesh Nagarkar, Student

Shubhangi Badar, Student

Cite this article: Nerkar AG, Nagarkar R, Badar S. Ethnopharmacological review of turmeric for anticancer activity. *Curr Trends Pharm Pharm Chem* 2023;5(1):10-15.