IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

"Curcumin And Its Effect: A Review"

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ABSTRACT:

Turmeric is a spice that comes from the rhizomes of *Curcuma longa*, a ginger family member (Zingiberaceae). Rhizomes are horizontal underground stems that produce both roots and shoots. Turmeric gets its vivid yellow colour from curcuminoids, which are fat-soluble polyphenolic pigments. Turmeric has been utilized in India for ages for medicinal purposes in addition to its use as a spice and colour.The goal of this review was to give a quick overview of curcumin's effects. Recent research has validated the use of turmeric for a variety of ailments, particularly those caused by oxidative stress, such as cancer, diabetes, and inflammatory disorders. Curcumin, a spice, has a lot of potential as a medicinal agent. It's also quite low in toxicity. As the worldwide landscape shifts toward the use of non-toxic plant items with traditional medicinal uses, the development of modern turmeric medications for the treatment of a variety of ailments should be prioritized.Turmeric has to be studied more in order to uncover hidden regions and realistic therapeutic uses that can benefit humanity.

KEY WORDS: Turmeric, Curcuma longa, Curcuminoids, Curcumin.

INTRODUCTION:

Curcumin is the main curcuminoid in turmeric, a renowned Indian spice that belongs to the ginger family (Zingiberaceae). Desmethoxycurcumin and bis-desmethoxycurcumin are the other two curcuminoids. Turmeric's yellow hue is due to the curcuminoids, which are polyphenols. Curcumin can be found in two different tautomeric forms: keto and enol.In the solid state and in solution, the enol form is more energetically stable. In the so-called curcumin approach, curcumin can be used to quantify boron. It combines with boric acid to generate rosocyanine, a red-colored chemical. Curcumin is a bright yellow pigment that can be used to colour foods. Its E number as a food additive is E100.[1]Turmeric (Curcuma longa) is an Indian rhizomatous medicinal plant with well-known medical advantages. Turmeric's therapeutic properties can be attributed to presence of active components known as curcuminoids. Curcumin, a small molecular weight polyphenolic molecule and lipophilic in nature, is one of the most intriguing components of curcuminoid.Soluble in ethanol, dimethylsulfoxide, and other organic solvents but insoluble in water and ether. Curcumin is stable in the stomach's acidic pH. Other components include volatile oils such as tumerone, atlantone, and zingiberone, as well as carbohydrates, proteins, and resins.Curcumin (1, 7-bis (4-hydroxy-3- methoxyphenyl)-1, 6-heptadiene-3,5-dione) is also called diferuloylmethane .

It's a tautomeric molecule that exists in both enolic and keto forms in organic solvents and water..[2]

Turmeric is a plant that grows in tropical and subtropical climates around the world. It is widely grown in Asia, particularly in China and India. The plant can grow up to 1 m tall and has a short stem. Turmeric is an important spice all over the world, having a long history of human use, particularly in the East.Because of its medicinal characteristics, it is utilized as traditional medicine in Asian nations such as India, Bangladesh, and Pakistan, in addition to being used as a spice. It's called turmeric, and it's been used for

flavouring and therapeutic purposes for centuries. Traditional medicine believes that its powder is effective against gastrointestinal ailments, particularly biliary and hepatic disorders, as well as diabetic wounds, rheumatism, inflammation.

Curcumin is responsible for the majority of the turmeric activities, according to extensive studies. It contains a number of beneficial characteristics, including antioxidant activity, and can help with inflammation, ulcers, and cancer. It has antifungal, antibiotic, and hepatoprotective properties as well. As a result, it has the potential to combat cancer, diabetes, allergies, arthritis, Alzheimer's disease, and other chronic and difficult-to-cure disorders. Recent research has validated the use of turmeric for a variety of ailments, particularly those caused by oxidative stress, such as cancer, diabetes, and inflammatory disorders.It is also used to treat AIDS as a hepatoprotective, nephroprotective, anticoagulant, and anti-HIV agent. Curcumin, a spice, has a lot of potential as a medicinal agent. It's also quite low in toxicity. As the global landscape shifts toward the usage of non-toxic plant items with long-standing medical applications,the development of modern turmeric medications for the treatment of various ailments should be prioritized. Turmeric has to be studied more in order to uncover hidden regions and realistic therapeutic uses that can benefit humanity.Turmeric has been proven to be anticancer, anti-diabetic, antioxidant, hypolipidemic, anti-inflammatory, antibacterial, anti-fertility, anti-venom, hepatoprotective, nephroprotective, anticoagulant, and other health benefits in recent studies. The plant has also been demonstrated to have anti-HIV action, making it useful in the fight against AIDS. Turmeric's therapeutic benefits have led to it being classified as a multipurpose spice.[3]

Composition of the Turmeric:

It has a high carbohydrate and fiber content. It also contains certain proteins and lipids, although it does not include cholesterol. It also includes enough amounts of pyridoxine, vitamin C, potassium, calcium,

magnesium, and phosphorus, making it one of the nutritionally dense natural food products.The nutritional profile of turmeric is shown in Table 1.[4]

Table 1: Turmeric nutritional profile[4]

Principle constituents	Nutrient value (kcal)	Percentage of RDA (%)
Energy	**354**	**17**
Carbohydrates	**64.9**	**50**
Total fat	**9.88**	**33**
Protein	**7.83**	**14**
Cholesterol	**0**	**0**
Dietary fiber	**21**	**52.5**
Vitamins		
Pyridoxine	**1.80**	**138**
Folates	**39**	**10**
Niacin	**5.140**	**32**

Riboflavin	**0.233**	**18**
Vitamin A	**0**	**0**
Vitamin C	**25.9**	**43**
Vitamin E	**3.10**	**21**
Vitamin K	**13.4**	**11**
Electrolytes		
Potassium	**2525**	**54**
Sodium	**38**	**2.5**
Minerals		
Manganese	**7.83**	**340**
Calcium	**183**	**18**
Copper	**603**	**67**
Iron	**41.42**	**517**

Magnesium	**193**	**48**
Phosphorus	**268**	**38**
Zinc	**4.35**	**39.5**

Main Products Table 2 lists the most commonly used turmeric items, along with brief explanations and applications in daily life.

Table 2: The main products of turmeric, their descriptions, and uses.[4]

Product name	Description	Uses
Whole rhizome (dried form)	Appearance: orange-brown, red-yellow, or pale yellow Chemical composition: it may contain 3–15% curcuminoids, and 1.5 to 5% essential oils Preparation: finger rhizomes and mother rhizomes are generally boiled, separately for about 40–60 min, under slightly alkaline conditions. It should then be sun-dried for 10–15 days to reduce the moisture content by roughly 10%.	Medicinal purposes

Ground turmeric	Appearance: Either yellow or red-yellow in color. Chemical composition: the major active components (curcuminoids and essential oils) may lose their potency during the procedure and as a result of light exposure. It is necessary to pack the powder in a UV protective container Preparation: dried finger rhizomes are grounded to produce its powder	Used as a spice, dye, medicine, and as a dietary supplement
Turmeric oil	Appearance: yellow to brown oil Chemical composition: essential oils from the leaves are usually dominated by monoterpenes. Rhizomes oil mainly contains sesquiterpenes Preparation: extract procured from dried rhizomes or leaves by steam distillation or supercritical CO2 extraction	Used as spice, medicine, and dietary supplement
Turmeric oleoresins	Appearance: dark yellow, reddish-brown viscous fluid Chemical composition: they consist of up to 25% essential oil and 37–55%	Used as a food coloring, medicine, and

	curcuminoids Preparation: extract from dried rhizomes by solvent extraction with organic solvents (acetone, dichloromethane, 1,2-dichloroethane, methanol, ethanol, isopropanol, and light petroleum (hexanes)) or by the application of supercritical CO2 extraction	dietary supplement
Curcumin	Color: yellow to orange-red crystalline powder Curcumin and its bisdemethoxy- and demethoxy-derivatives are combined in the chemical composition (no fixed proportions). The three primary curcuminoids could account for up to 90% of the total.Oils and resins may make up a small percentage of the total composition. It is prepared by solvent extraction from pulverised turmeric rhizomes, followed by purifying of the extract via the crystallisation process. Acetone, carbon dioxide, ethanol, ethyl acetate, hexane, methanol, and isopropanol are some of the organic solvents utilised in extraction.	Used as medicine and dietary supplement

Molecular Constituents Turmeric is made up of a number of molecular components, each of which has a different biological activity. For example, there are at least 20 antibiotic compounds, and 14 of their constituents have been shown to have cancer-preventive properties. In addition, 12 of its compounds have anticancer properties, while the remaining 12 have anti-inflammatory properties.It also has at least ten molecular components that are antioxidants. Turmeric has been found to have 326 biological activity. Curcumin, bisdemethoxycurcumin, and demethoxycurcumin are three gold-colored alkaloids curcuminoids that have been extensively studied in turmeric.[4]

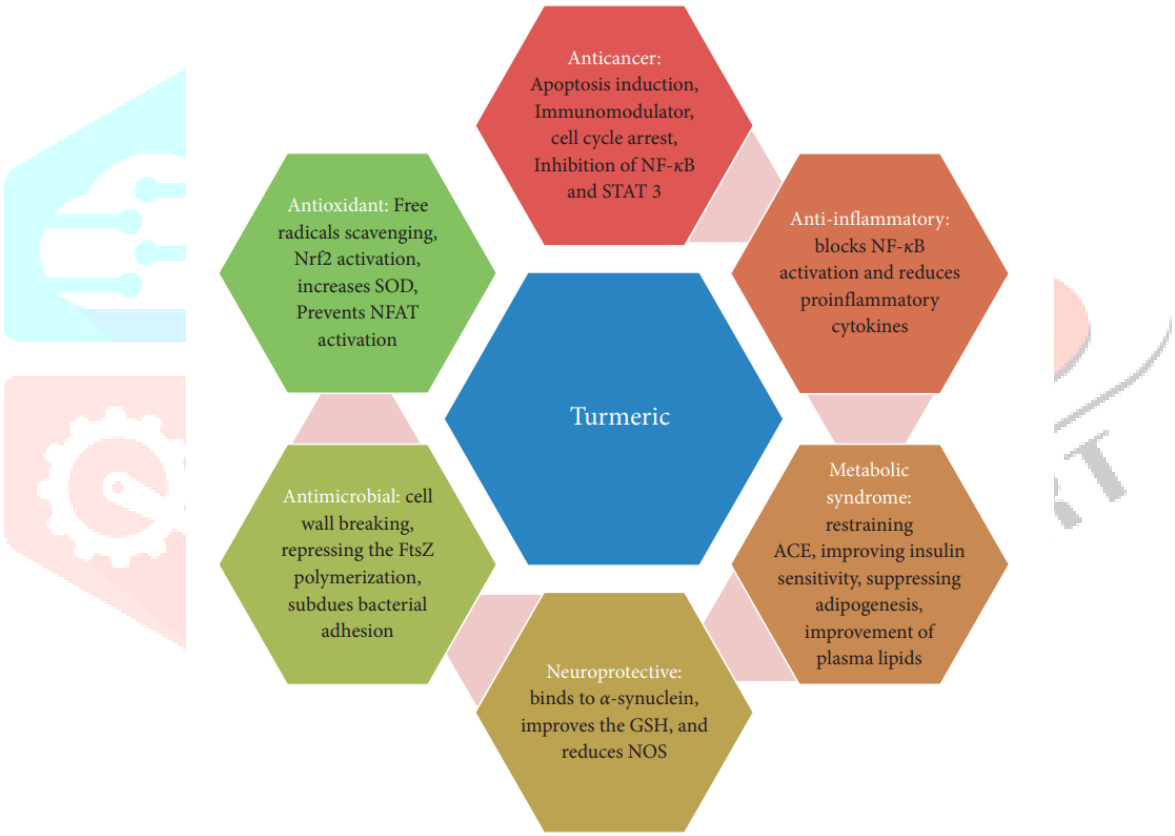

Figure 1:Diagram depicting turmeric's therapeutic properties in terms of some of the most important mechanisms.[4]

Anticancer Effect:

C.longa is a plant that has been used to treat a variety of ailments. Turmeric and its constituents are multitargeted phytochemicals that can be used to cure cancer. Their use, for example, can alter apoptosis, autophagy, and cell cycle arrest.Curcumin inhibits a wide range of signalling pathways, including p53, Ras, phosphoinositide 3-kinase, AKT, Wnt/-catenin, and mammalian target of rapamycin. Turmeric also affects the regulation of microRNA network expression. Curcumin inhibits the activity of histone deacetylases in vitro and in vivo investigations, it should be emphasized.[4]Turmeric's effect on carcinogenesis has been studied in a number of animal experiments. Curcumin has been shown to reduce carcinogenesis at three stages: angiogenesis, tumour promotion, and tumour growth in several investigations. Curcumin was found to reduce cell proliferation and tumour growth in two investigations of colon and prostate cancer.Turmeric and curcumin can also inhibit the activities of a number of mutagens and carcinogens. Turmeric and curcumin have been linked to anticarcinogenic effects due to their direct antioxidant and free-radical scavenging properties, as well as their potential to indirectly boost glutathione levels, assisting in hepatic detoxification of mutagens and carcinogens, and blocking nitrosamine formation.Curcumin has also been demonstrated to prevent UV radiation from causing mutagenesis.[6]

Colorectal cancer:

It is a type of cancer that affects the intestines colorectal cancer (CRC) has recently become a major public health concern. Obesity and its associated metabolic problems have been linked to colorectal carcinogenesis, according to research. Obesity and the progression of CRC have been linked by a variety of biological mechanisms.Obesity-related colorectal carcinogenesis is aided by insulin resistance and changes in the insulin-like growth factor-1 (IGF-1). It's also worth noting that the level of tumour necrosis

factor (TNF-) in adipose tissue rises, which is linked to tumour promotion and the development of carcinogenesis.Curcumin could be a quick fix for obese people who want to avoid getting CRC. In fact, it activates AMP-activated kinase by reducing the presence of COX-2 protein and inhibits the action of nuclear factor-B (NF-B) on colon mucosa. Curcumin also lowers the level of leptin in the blood, while increasing the level of adiponectin.Poloxamer 407 can be employed as a polymer to expand the colorectal medicine liberation mechanism for curcuminoids in CRC treatment, according to another study. Turmeric has antitumor and anticancer properties by inhibiting NF-B establishment and downregulating NF-B-related gene products linked to cancer cell endurance, propagation, and metastasis.Turmeric also promotes the production of reactive oxygen species (ROS) and inhibits the growth of tumour cell types. Turmeric also boosts the tumour cells' sensitivity to capecitabine and taxol (chemotherapeutic drugs).It also inhibits NF-B activation induced by the receptor activator of nuclear factor-kappa B ligand (RANKL), which is linked to osteoclastogenesis inhibition. As a result, turmeric can effectively inhibit tumour cell proliferation by suppressing the NF-B and STAT3 pathways.Turmeric has also shown in vitro and in vivo that it can overcome the challenge of P-glycoprotein-mediated multidrug resistance in CRC.[4]

Renal cancer:

It is a cancer that affects the kidneys. Long-term exposure to 10 M curcumin modifies the swelling-activated chloride current in a dose-dependent manner in a human kidney cell line. At a dosage of 5.0–10 M, curcumin promotes apoptosis in human kidney cells and causes the emergence of a subpopulation of cells with increased volume.Curcumin at 50 micrograms per millilitre induces apoptosis and increases the growth of colorectal cancer cells. The cell cycle halt could be the cause of the cell line's increased growth following exposure to curcumin.[4]

Hepatic cancer:

It is a cancer of the liver. Yu and colleagues investigated the molecular pathways of apoptosis induction in human hepatoma SMMC-7721 cells in another study. Curcumin inhibits the development of SMMC-7721 cells by triggering apoptosis via regulation of bax/bcl-2, according to the researchers.Curcumin appears to target the spindle assembly checkpoint in order to cause apoptosis in cells with phosphorylated cell division cycle 27. (CDC27). The method by which curcumin exerts its anticancer action is phosphorylation of CDC27. Curcumin stimulates the apoptotic pathway and inhibits cell growth and proliferation, resulting in cell death.[4]

Bone cancer:

It is a disease that affects the bones. Dennis and colleagues established a novel strategy in amalgamation treatment for osteosarcoma by combining a synthetic counterpart of the natural chemical pancratistatin with curcumin. Curcumin's limited water solubility limits its use, despite its potent antiproliferative and antiinflammatory qualities.Using poly-lactic-coglycolic acid, one controlled investigation documented the production and characterisation of nanocurcumin. The indicated nanoparticulate formulation's water solubility and anticancer activity seems to have greatly enhanced.[4]

Lung cancer:

It is a cancer that affects the lungs. *C. longa* is now known to possess tumor-inhibiting gears, both in vitro and in vivo. Curcumin has been shown to promote tumour progression, reducing the efficacy of docetaxel in lung cancer patients. Similarly, synchronised curcumin and docetaxel treatment causes minor toxicity in normal organs, as well as the bone marrow and liver.[4]

Blood Cancer:

Cancers of the Bloodand Other Organs Curcumin has also been shown to inhibit the growth of a range of malignant cell types, including lymphoma cells. Curcumin therapy of Burkitt's lymphoma cell cell lines in combination with ionising radiation (IR) shows that curcumin increases lymphoma cell susceptibility to IR-induced apoptosis and improves G2/M phase arrest in the cell cycle.As a result, the antiapoptotic Bcl-xL cell cycle altering protein has been found to be downregulated. Curcumin-induced G2/M phase arrest was linked to a significant reduction in cyclin A, cyclin B, and cyclin-dependent kinase 1 protein expression.Curcumin-induced apoptosis is also accompanied by an increase in Bax protein expression and a decrease in Bcl2 protein quantity, resulting in mitochondrial malfunction. As a result, cytochrome c is released, and caspase-9 and caspase-3 are sequentially activated in nasopharyngeal carcinoma-TW 076 cells.As a result, it appears that mitochondrial and apoptosis-inducing factor caspase-3-dependent pathways are the key players in curcumin-induced G2/M phase arrest and cell apoptosis. Curcumin also reduced p65 nuclear translocation and cytoplasmic IB dilapidation significantly. The curcumin pretreatment has a tendency to lower survivin and hexokinase II levels.Curcumin and L-asparaginase (LASP) combined therapy induces apoptosis by activating different cysteine proteases (caspase-8 and caspase-9/3) as well as the phase-I detoxification system. Curcumin and L-ASP have a synergistic effect in patients with blood and bone marrow malignancy.Curcumin also inhibits the growth of uterine leiomyosarcoma cells and reduces the spread of castrate-resistant disease and human leiomyosarcoma cell lines by targeting the AKT-mammalian target of rapamycin pathway for reluctance. Curcumin reduces T cells in significant numbers, but a modest dose of curcumin boosts T cells retrieved from mice with the 3LL tumour.As a result, increased CD8+ T cells demonstrated improved IFN-c discharge and proliferation, particularly against 3LL tumour cells, resulting in tumour inhibitory abilities.The antiproliferative effects of turmeric components on human cancer cell lines such as MDAMB-231, MCF-

7, and HepG2 as well as the immunomodulatory effects of turmerones on human blood mononuclear cells revealed that alpha-turmerone and curcuminoids significantly decrease cancer cell formation.After using alpha-turmerone and aromatic-turmerone, researchers saw an improvement in the proliferation of peripheral blood mononuclear cells and the composition of cytokines.[4]

Antibacterial Effect:

Turmeric could be used as an antibacterial option in the fight against deadly bacterial infections. Fungal growth, as well as the generation of aflatoxins B1 and G1, are considerably inhibited when turmeric essential oil is used. Curcumin has a low water solubility, which makes it difficult to use.The antibacterial activity of nanocurcumin is achieved by fully destroying the cell wall, resulting in cell death. In the presence of epigallocatechin gallate, curcumin antibacterial activity against multidrug-resistant Acinetobacter baumannii increases noticeably (EGCG). In medicine, a combination of EGCG and curcumin can be used to prevent or treat Acinetobacter baumannii infections.Elimination of Acanthamoeba castellanii (as the causal agent for Acanthamoeba keratitis and granulomatous amoebic encephalitis) is problematic since the amoebas encyst makes it rebellious to antiamoebic medications. On Acanthamoeba castellanii cysts, ethanol extracts of various plants, including peanut, sea daffodil, and turmeric, were tested for amoebicidal efficacy.The extracts' inhibitory effect on Acanthamoeba cyst duplication was supported by the findings. The effect, however, was time and dose dependent. Additionally, turmeric mouthwash can be used as an adjuvant to mechanical plaque management procedures for plaque and gingivitis prevention.Curcumin also inhibits infectivity and cell proliferation in a dose-dependent manner. By limiting Vibrio vulnificus growth, it greatly reduces Vibrio vulnificus cytotoxicity to HeLa cells. Curcumin inhibits bacterial adherence to host cells as well as RTX toxin binding.Curcumin also prevents rounding of the host cell and actin aggregation. Curcumin also inhibits the NFB translocation caused by V. vulnificus in HeLa cells. It's worth noting that curcumin, the major

component in turmeric, has antiviral properties across the board. There are multiple research on its many mechanisms against human immunodeficiency viruses, for example (HIVs).Furthermore, this polyphenol and its analogues can stop viral genes from infecting and replicating. They suppress HIV protease and HIV-associated kinases (e.g., tyrosine kinase). Curcumin also has a synergistic impact when combined with other medicines.

Curcumin inhibits the redox activity of the Apurinic/ apyrimidinic endonuclease-1 enzyme.Curcumin has been shown to suppress Kaposi's sarcoma-associated herpesvirus replication and thereby modulate pathologic processes (such as angiogenesis). A lot of studies have been conducted on the anti-influenza activity of turmeric's biological ingredients. It can stop the influenza A virus (IAV) from adhering to surfaces and replicating.Furthermore, in IAV infection, curcumin helps regulate the immune system response by inhibiting local inflammatory cytokines. In macrophages, it also has a modulatory influence on NF-B signalling. Finally, it has the potential to protect and alleviate IAV-related lung injury.[4]

Neuroprotective Effects:

Plant-derived components have been shown to promote neuroprotection as well as control biochemical pathways connected to symptoms of neurodegenerative illnesses such as cognitive deficits, energy loss/fatigue, mood abnormalities, and anxiety. It also has neurogenic properties, which appear to be achieved through stimulating neural stem cell proliferation and diffrentiation.Plants and their compounds with neuroprotective properties could be a new treatment option for Parkinson's disease (PD). A proposed mechanism that leads to PD is the accumulation of -synuclein protein at high temperatures.The unfolding of the tetramer to kinetically trapped monomers leads to the development of fibrillar Lewy bodies, which is a physiological mechanism involved in aggregation. As a result, preventing monomer reassociation could be a useful therapeutic strategy for PD prevention.Investigators observed the ability of turmeric's

component to bind to -synuclein, preventing the protein from aggregating and, as a result, escalating the pace of rearrangement into a faster regime, in a few research investigations. However, the majority of research papers emphasising turmeric's neuroprotective properties in PD used rat models with varying study lengths.. Turmeric stimulated the enzymatic action of c-glutamyl cysteine ligase and protected neurons in the brain from protein nitration and disintegration, according to some of their findings. Another issue is the advent of oxidative stress, which can lead to mitochondrial damage and PD. In experimental settings, turmeric enhances glutathione (GSH) synthesis, lowering free radical damage and indeed oxidative stress.Curcumin bioconjugates can protect dopaminergic neuronal cells from oxidative stress and promote neuroprotection. BDNF, phosphor-tyrosine kinase B (TrkB), phosphor-extracellular signal-regulated kinase, and AKT are all improved by curcumin. Curcumin's neuroprotective effects are thought to be mediated by the BDNF/TrkB-MAPK/PI-3K-CREB signalling pathway.

Chronic inflammatory responses associated to both brain damage and beta-amyloid-related pathology are included in Alzheimer's disease (AD). The combination of oxidative stress and disturbed protein metabolism, as well as their interplay, has been shown to be crucial in the aetiology of Alzheimer's disease. Turmeric extract may be useful in the prevention of Alzheimer's disease.Many changes occur in the brains of Alzheimer's patients (for example, protein synthesis is disrupted, protein shortage occurs, and the heat shock response (HSR) is unbalanced). The HSR protects cells from a wide range of stressors. Curcumin may be used as part of a diet to help reduce oxidative stress and amyloid pathology in Alzheimer's disease.It has the potential to be a powerful weapon in the prevention of Alzheimer's disease. Researchers are interested in encapsulating bioactive components because of their reported higher efficacy. Researchers tested the cytotoxicity of curcumin nanoparticles encapsulated in a study (Nps-Cur). The human neuroblastoma SK-N-SH cells treated to Nps-Cur showed the least evidence of toxicity, according to them.As a result, Nps-Cur may be a viable approach for providing neuroprotection to

Alzheimer's patients. The amplified TdT-mediated dUTP nick-end labelling (TUNEL) positive cells in brain sectors, which signify DNA disintegration, are linked to cerebral ischemia.During cerebral ischemia, curcuma oil treatment may assist to lower nitric oxide synthase (NOS) isoforms and a significant decrease in the number of apoptotic cells. Curcumin also inhibits the production of the chemokine CCL2 mRNA and protein in C6 cells stimulated by lipopolysaccharide.Water-soluble curcumin formulations (50–200 mg/kg) shorten the period of tranquilly and increase serotonin and dopamine levels in brain tissues. As a result, these curcumin formulations may offer a novel avenue for neurotransmitter modulation and the therapy of mental illness. Finally, investigations on turmeric's neuroprotective effects in traumatic brain injury have been conducted.Reduced oxidative stress and cerebral edoema, increased BDNF levels, synaptic protein and mitochondrial protection, and microglial activation were all found to have this effect. It has also been demonstrated to reduce IL-6, TNF-, IL-1, and MCP1 levels while improving toll-like receptor 4 and aquaporin-4 expression.Furthermore, one of the most essential mechanisms for this effect is the activation of the Nrf2 pathway.[4]

Turmeric has been found to suppress the growth of a wide range of bacteria, fungus, and parasites. In a trial of Eimera maxima-infected chicks, meals supplemented with 1% turmeric reduced intestinal lesion and enhanced weight gain.Topically applied turmeric oil suppressed dermatophytes and harmful fungus in guinea pigs 7 days after administration in another animal investigation. Curcumin also has some action against Plasmodium falciparum and Leishmania major organisms.[6]

Millions of individuals worldwide suffer from neurodegenerative disorders such as Parkinson's disease (PD) and Alzheimer's disease (AD), as well as significant depression and epilepsy, which are all on the rise. Neuroinflammation is a type of persistent inflammation that causes alterations in neuronal metabolism, which leads to neuronal degeneration.The latter are in charge of the production of proinflammatory cytokines including TNFa and IL-1. Curcumin has been proposed as a potential

therapeutic agent for a variety of neurological disorders, including dementia, Alzheimer's disease, Parkinson's disease, multiple sclerosis, and Huntington's disease (HD), based on existing research. It has antioxidant, anti-inflammatory, and anti-protein aggregating properties.[5]

Antioxidant Effect:

The antioxidant effects of curcumin have been studied the most in the literature. Curcumin's antioxidant capacity has been related to its chemical structure, which includes carbon carbon double bonds, b-diketo group and phenyl rings with hydroxyl, and o-methoxy groups, according to many in vitro and in vivo investigations.Antioxidant activity can be explained by a variety of processes, including the binding of free radicals, hydrogen atom donors, and electron donors to neutralise free radicals. The mechanism of action of curcumin's antioxidant activity has been elucidated using laser flash photolysis and pulse radiolysis.Curcumin enhances its antioxidant activity by scavenging reactive oxygen species (ROS) such as superoxide, hydrogen peroxide, and nitric oxide (NO) radicals, as well as preventing lipid peroxidation. Many antioxidant enzymes, including as SOD, CAT, GPx, and OH-1, are activated, resulting in this latter action.Curcumin can also boost GSH levels by boosting glutathione transferase and its mRNAs. Curcumin can also block the production of reactive oxygen species (ROS) by enzymes such LOX, COX, and xanthine oxidase. Because of its lipophilic nature, curcumin is also thought to be a chain-breaking antioxidant, possibly working as a peroxyl radical scavenger.[5]

Curcumin has been found to be a potent oxygen free radical scavenger. It has antioxidant properties similar to vitamins C and E. It can prevent the oxidation of lipids or haemoglobin. It can greatly reduce the production of reactive oxygen species (ROS) in activated macrophages, such as H2O2, superoxide anions, and nitrite radicals.Bisdemethoxycurcumin and demethoxycurcumin, two of its derivatives, show antioxidant properties as well. Pre-treatment with curcumin has been found to reduce ischemia-induced

oxidative stress and cardiac abnormalities. Curcumin increased cellular resistance to oxidative damage in an in vitro evaluation of its effect on an inducible stress protein.[6]

Anti-inflammatory effect:

Curcumin has been demonstrated to have anti-inflammatory properties.

1.Pro-inflammatory transcription factors (NF-kB and AP-1) are inhibited.

2.TNFa, IL-1b, IL-2, IL-6, IL-8, MIP-1a, MCP-1, CRP, and PGE2 are all proinflammatory cytokines that should be reduced.

3.Reduce the activity of enzymes like 5-lipoxygenase and COX-2.

4.Inhibit the nitric oxide synthase (NOS) enzymes' synthesis via inhibiting mitogen activated protein kinases (MAPK) related pathways.

On the other hand, because oxidative stress causes chronic inflammation, a link between antioxidant molecules and their anti-inflammatory properties is becoming more apparent. Curcumin can affect the expression of NF-kB in this way. In fact, activation of the NF-kB pathway results in the generation of proinflammatory cytokines.TNFa and interleukin (IL-1, IL-2, IL-6, IL-8) are two proteins that are known to activate pro-inflammatory signalling pathways. Curcumin may also reduce oxidative stress and inflammation by activating the Nrf2 pathway. Two COX isoenzymes (COX-1 and COX-2) are involved in the conversion of arachidonic acid into prostaglandins and thromboxanes via the COX pathway.COX-2 is induced by a variety of cytokines and tumour promoters, and is thus associated to inflammation and carcinogenesis, with numerous studies suggesting that curcumin can suppress COX-2 gene expression induction.[5]

Hepatoprotective Effect:

A variety of substances, including alcohol, narcotics, pollutants, parasites, and dietary ingredients, can cause acute and chronic liver damage, such as liver fibrosis, non-alcoholic steatohepatitis, non-alcoholic liver disease, and even cirrhosis.Curcumin's hepatoprotective effects have been extensively researched (Rahmani et al., 2016; Tung et al., 2017; Peng et al., 2018; Macas-Perez et al., 2019). Choudhury et al. (2016) found that a curcumin injection (8.98 M) lowered NADH oxidase and elevated GR, GST, and succinate dehydrogenase activity in Swiss albino rats with CCl4-induced hepatotoxicity.Curcumin administration (200 mg/kg) in Sprague-Dawley rats enhanced hepatic glutathione levels and decreased lipid peroxidase levels as well as the activities of both alanine transaminase (ALT) and aspartate aminotransferase (AST) for the same type of hepatotoxicity (Lee et al., 2016).Curcumin, by lowering ALT, AST, and alkaline phosphatase levels, raising GST, GR, GPx, SOD, and CAT, and reducing NO and blocking ROS formation, may be a viable drug for preventing oxidative stress-related liver disease (Farzaei et al., 2018).Curcumin therapy boosted endogenous antioxidant levels (ascorbic acid, GSH, SOD, and CAT) in the liver of chronic iron overloaded male rats, according to Badria et al. (2015). Curcumin was able to reduce the effects of drug-induced hepatoxicity in mice, such as that caused by streptozotocin and paracetamol usage.Curcumin reduced TNFa, IL-1ß, MAPK, and apoptosis signal-regulating kinase 1 (ASK1) in liver tissues of Sprague Dawley rats with streptozotocin-induced diabetes, according to Afrin et al. (2015).Curcumin treatment reduced oxidative stress, inflammation, and lipogenesis, as well as fibrosis and HMGB1-NF-kB translocation and signalling, in non-alcoholic steatohepatitis induced by low-dose streptozotocin and a high-fat diet, according to Afrin et al. (2017).Curcumin administration reduced paracetamol-induced hepatotoxicity by scavenging free radicals, inducing antioxidant enzyme expression, and inhibiting the NF-kB and transient receptor potential melastatin 2 (TRPM2) channels (Granados-Castro et al., 2016; Kheradpezhouh et al., 2016).[5]

Anti-diabetic and cardiovascular Effects:

Turmeric protects the heart by acting as an antioxidant, lowering lipid peroxidation, acting as an anti-diabetic, and inhibiting platelet aggregation.In a study of 18 atherosclerotic rabbits given turmeric extract at doses of 1.6-3.2 mg/kg/day, the susceptibility of LDL to lipid peroxidation was reduced, as well as plasma cholesterol and triglyceride levels. Turmeric's cholesterol-lowering effect could be due to decreased cholesterol absorption in the intestines and increased cholesterol conversion to bile acids in the liver.Turmeric components are hypothesised to prevent platelet aggregation by potentiating prostacyclin synthesis and inhibiting thromboxane formation. In diabetic rats, both turmeric and ginger lower blood glucose levels. Turmeric also helps those with diabetes mellitus avoid problems.. More clinical research is needed in this area to determine the best dosages for cardiovascular protection and cholesterol or glucose reduction.[6]

Gastrointestinal Effects:

Turmeric has a number of gastrointestinal-protective properties. Turmeric also prevents ulcer formation in rats exposed to gastrointestinal irritants such as stress, alcohol, Indomethacin, Reserpine, and pyloric ligation by increasing stomach wall mucus. It also reduces intestinal spasms and boosts the release of bicarbonate, gastrin, secretin, and pancreatic enzymes.

An open, phase II trial on 25 patients with endoscopically diagnosed stomach ulcers who were administered 600 mg powdered turmeric five times daily indicated that 48 percent of the patients were totally cured. There were no reported side effects or blood abnormalities. In mice with experimentally induced colitis, curcumin decreased mucosal damage.Administration of 50 mg/kg curcumin ten days prior to induction of colitis with 1, 4, 6-trinitrobenzene sulphonic acid resulted in a considerable reduction of diarrhoea, neutrophil infiltration, and lipid peroxidation in colonic tissue. In addition, all signs of

inflammation decreased, and symptoms improved. Curcumin reduced inflammation in rat models of experimentally induced pancreatitis.Curcumin was also able to block inflammatory mediators in cerulean or ethanol-induced pancreatitis, which resulted in a reduction in disease severity as determined by histology, pancreatic trypsin, serum amylase, and neutrophil infiltration.[6]

Hepatoprotective and renoprotective Effects:

Turmeric, like silymarin, has been proven to have renoprotective and hepatoprotective effects. Turmeric has been shown in animal experiments to exhibit renoprotective and hepatoprotective properties against a variety of hepatotoxic stimuli.

Turmeric's antioxidant qualities, as well as its capacity to reduce the generation of pro-inflammatory cytokines, are responsible for its hepatoprotective and renoprotective effects (3-5). Aflatoxin-induced lipid alterations, biliary hyperplasia, and necrosis have also been corrected by turmeric and curcumin.Sodium curcuminate, a salt of curcumin, increases biliary excretion of bile salts, cholesterol, and bilirubin, as well as bile solubility, potentially preventing and curing cholelithiasis.[6]

Photo-protector Effect:

This is owing to its antioxidant properties. Unsaturated lipids make up a major portion of the skin's surface lipids. As a result, free radicals have an easy time attacking them. The sun's UV rays penetrate the skin, speeding up the damage produced by free radicals. Long-term exposure to these rays may cause lipid degradation, resulting in a change in skin texture. In lab tests, turmeric extract was found to be beneficial in reducing inflammation and protecting epidermal cells from UVB radiation damage. Curcumin has been demonstrated to protect against chromosomal damage caused by gamma radiation in tiny dosages of turmeric.[6]

Conclusion:

Curcumin has gotten a lot of attention because of its numerous health benefits, which appear to be mediated mostly through anti-oxidant and anti-inflammatory pathways. Curcumin may aid in the treatment of oxidative and inflammatory disorders, metabolic syndrome, arthritis, anxiety, and hyperlipidemia, according to a review. It may also aid in the treatment of exercise-induced inflammation and muscular pain, allowing active persons to recover faster and perform better. Furthermore, even if a person does not have a documented health condition, a relatively low dose can bring health benefits. Given the findings that the modest amounts of curcuminoids in turmeric powder are poorly accessible, culinary levels of turmeric powder added to foods for sensory purposes are unlikely to provide considerable health benefits for the illnesses investigated. Curcuminoid extracts and other new formulations may have the ability to help manage symptoms, particularly arthritis, based on current, preliminary results from human trials. However, given to inconsistencies in findings from trials of varying quality, as well as an imperfect understanding of curcuminoids' effective dosage and duration, as well as their safety and interactions. Researchers often pointed to disorders including diabetes, wound healing, arthritis, alzheimer's, parkinson's, inflammatory, venom, angiogenesis, cataract, cancer, atherosclerosis, and hypertension as examples of curcumin's most obvious therapeutic value. Curcumin is high in several beneficial phytoconstituents, which are responsible for its clinical and experimental success. Anti-inflammatory, anti-allergic, antioxidant, anti-hyperglycaemic, anti-cancer, antimicrobial, anti-atherosclerosis, and anti-hypertension effects have been established. Curcumin has been identified as a possible option for the prevention or treatment of a variety of diseases due to its ability to effect a wide range of molecular targets and its favourable safety profile.

Acknowledgement:

The authors of this review article are thankful to the Principal, Government College of Pharmacy, Karad for allowing us to present this paper. We are also thankful to the AICTE for providing research fellowship to complete our research work and convert our research work into the publications.

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