

## Review

# Therapeutic potential of Curcumin in *Curcuma Longa*: A Review

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### Abstract

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Curcumin is a poly-phenol active compound of *Curcuma Longa* (Turmeric). It belongs to the Zingiberaceae family. In developing countries, turmeric and its products are consumed to overcome many ailments because of cost effectiveness. It is frequently used in herbal medicine. It shows strong therapeutic potential as an antioxidant, anti-fungal, anti-bacterial, anti-inflammatory, and anti-cancerous. It plays a prominent role in management of many diseases and disorders *i.e.* arthritis, diabetes, diabetic micro-angiopathy, diabetic nephropathy, psoriasis, gastro-Intestinal diseases, acute cardiac diseases, anxiety, hyper-lipidemia, bacterial infection and inflammation. It is safe to use and shows no side effects or toxicity but sometimes it can cause low fertility, bleeding disorders, low glucose level and heavy menstruation. Curcumin acts as an anti-oxidant and also helps to fight against diseases.

**Keywords:** Anti-inflammatory, Anti-oxidant, Curcumin, Poly-phenol, Reactive oxygen species, Therapeutic potential

## INTRODUCTION

Turmeric (*Curcuma longa* L.) belongs to the ginger family Zingiberaceae (Bachmeier and Melchart, 2019). *Curcuma longa* has an extensive account of use in customary medicinal practices of the Ayurvedic and Unani systems of herbal medicine, as well as in traditional Chinese medicine, for treating liver and digestive disorders. In Ayurvedic medicine, turmeric was used as a treatment of inflammatory conditions (Ross 2018). Indian traditional medicine has successfully established the use of turmeric for rhinitis, gastrointestinal symptoms, wound healing, rheumatic disorders and deworming and as a cosmetic (Argilashki and Hadzhieva, 2018).

Turmeric also has many topical and commercial uses. Its red alkaline form is conventionally measured to the face and feet by women in South Asia as socio-religious "markings." It revitalizes the complexion and protects the skin from infection, and is used to treat pain, burns, inflammation and open wounds in skin and soreness in the mouth. Essential oil extracted from turmeric is used in

perfumes, and it has long been utilized as a yellow vegetable dye for cloth (Rafi, 2016).

### Curcumin and Curcuminoids

Chemical components of *Curcuma Longa* which are important is group of compounds known as curcuminoids in which curcumin (diferuloylmethane), bisdemethoxycurcumin (BMC), demethoxycurcumin are included. Curcumin is the best studied compound which consists of 3.14% of powdered Turmeric (Javeri and Chand, 2016). Curcumin is used as an additive due to its stability in thermal treatment and in dry foods. It is not reactive with phosphate, bicarbonate and chlorides but with citrates and phthalates it may form salt. Curcumin is soluble in oils, not soluble in water at neutral and acidic pH, but gets soluble in water in alkaline conditions. PH level effects curcumin color, it is intense yellow at PH between

2.5-7.0, and red at PH level above 7.0 (Jovičić, Jozinović et al., 2017).

Turmeric which is used as spice also known as curcumin longa has a polyphenol known as Curcumin which has shown to target multiple signaling molecules while also demonstrating activity at the cellular level, providing lot of health benefits (Tsuda, 2018). It shows benefit on inflammatory conditions, metabolic syndrome, and pain and is also helpful in inflammatory and degenerative eye conditions. It has also shown beneficial effects on kidney whereas it has multiple therapeutically effects as a supplement mostly related to its antioxidant & anti-inflammatory property (Hewlings and Kalman, 2017).

### Metabolism of curcumin

Due to its vigorous health benefits and biological activities curcumin metabolism is critical. Curcumin is present in three major forms in the mammalian body, free, reduced and conjugated states. Mainly, oral administration metabolizes curcumin in conjugated curcumin through sulfation and glucuronidation. The study shows that the human digestive tract has an important role in glucuronidation of curcuminoids. In addition, intraperitoneal administration leads towards reduction of curcumin into tetrahydrocurcumin, dihydrocurcumin and an important role in the glucuronidation of curcuminoids. In addition, intravenous or intraperitoneal administration leads to the reduction of curcumin into hexahydrocurcumin, dihydrocurcumin and tetrahydrocurcumin (Xu, Meng et al., 2018).

Curcumin's anti-inflammatory property is due to the capability for the modulation of NFκB (transcription factor). Curcumin delays aging and increases the lifespan of organisms (Bachmeier, 2019).

### Therapeutic Effects

#### Anti-cancer effect:

Inflammation-driven diseases gets trigger due to environmental and dietary factors and cancer is one of them. Many naturally occurring compounds present in vegetable and fruits have been found to inhibit the oxidative damage, alleviate nitrosamine formation, bind and dilute the carcinogens in the gastrointestinal tract and also prevent malignant transformation of cells in the body. It has also been found out recently that curcumin is an epigenetic modulator (Shanmugam, Arfuso et al., 2019). Curcumin has anticancer properties which affect cancerous and tumor cell growth (Basnet and Skalko-Basnet, 2011).

After breast and lung cancer, colorectal cancer (CRC) is ranked third most common cancer in the world and second most common cause of cancer death according

to WHO (2018). Radiation, chemotherapy and surgery are some of orthodox methods used for cancer treatment worldwide. Nowadays natural compounds like resveratrol, curcumin (CUR), gingerol, folate and lycopene are also gaining attention as they have chemo preventive properties with least side effects. Curcumin is being used for the treatment of various cancers which includes colorectal, pancreatic, breast, prostate, lung and oral cancers alone or by combining with other natural (Wong, Ngai et al. 2019).

The effects of curcumin-reduced 1-tyrosine reduce AgNPs (T-AgNPs), AgNPs (C-AgNPs) and free curcumin on the viability of human epidermoid carcinoma cell line (A431 cells). C-AgNPs and T-AgNPs are toxic to the skin carcinoma (A431) cells as compared to the free curcumin at higher concentration (60 µg/mL). It acts as a chemotherapeutic agent due to its anticancer activity of C-AgNPs (Shah, Savaliya et al., 2018).

#### Curcumin as wound healing agent:

Antioxidant and anti-inflammatory property of curcumin acts as a wound-healing agent at different stages of the healing process. Curcumin acts as anti-oxidant and inhibits the oxidative degradation of lipids, reduces the oxidation, reduces oxidative stress through non-enzymatic and enzymatic mechanisms. Migration of various cells like fibroblasts, macrophages increases towards the wound side in the proliferation stage and neovascularization also increases the collagen content and tissue formation. In last stage remodeling it helps in transforming growth factor and Increase biosynthesis of extracellular matrix (ECM), which can cause the wound contraction (Mohanty and Sahoo, 2017).

*Pseudomonas aeruginosa* growth is lowered by curcumin. Experiments on rats have shown beneficial effect of curcumin in wound healing even in burn condition (Hussain, Thu et al., 2017).<sup>1</sup>

#### Antimicrobial effect

Beneficial effects of curcumin against pathogens causing infectious disorder have been found. Recently curcumin have shown inflammatory parameters cytokine, chemokine, and Toll-like receptor (TLR) PCR assays in *H.pylori* infection conducted on rats (Padmanaban and Rangarajan, 2016).

Curcumin protects against many micro-organism *i.e.* Gram negative and Gram positive bacteria, *E.coli*, *Streptococcus mutans*, *Streptococcus epidermidis*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Shigella dysenteriae* etc. Demethoxycurcumin and Curcuminoids present in turmeric act as an anti-microbial agent (da Silva, de Freitas Santos et al., 2018).

### **Curcumin as Cardio-protective agent**

Nowadays cardiac diseases are a major cause of death. Many pathological processes are affected by curcumin in heart. It protects against myocardial Infarction and atherosclerosis by lowering the cholesterol serum and fat (LDL). By improving the transporting of Calcium from heart muscles it protects from heart diseases (Bernardo and McMullen 2016).

By lowering the p300-HAT curcumin prevents heart failure. Many studies have shown the cardio-protective property of curcumin (Rahmani, Alsahli et al., 2018). Study shows that by lowering the toxicity of sodium fluoride curcumin lowers heart failure risks (Nabavi, Moghaddam et al., 2012). It is also effective against cardiomyocytes, cardiac hypertrophy, oxidative stress and many inflammatory events (Izem-Meziane, Djerdjouri et al., 2012). According to study it reduces HDL to 29%, Serum lipid to 33% and cholesterol level to 12% in body. That's how it plays a cardio-protective role (Hashemzaei, Heravi et al., 2017).

### **Anti-diabetic effect**

Curcumin weakens the consistency of blood glucose by increasing insulin and LPL activity. Gluconeogenesis, glycolysis, and lipid metabolism can get affected by curcumin. Blood glucose, hemoglobin (Hb), and HbA1C levels reduces if curcumin is given in combination with vitamin C and yogurt also reducing weight. Intake of curcumin is also linked with decreased lymphocyte penetration rate and small islets pancreatic (Yadollahi and Zargarani 2019). Many small studies have proven the anti-diabetic property of curcumin in animal models (Wojcik, Krawczyk et al., 2018).

Recently curcumin anti-diabetic mechanisms have been explained in many studies. Many benefits of curcumin could be explain by titillation of insulin which were seen in diabetic rat which was treated with curcumin and yogurt combination like reducing the glycemia and glycosuria, increasing the weight of adipose muscle tissues and portion control in comparison with rats treated only with yogurt (Arcaro, Gutierrez et al., 2014).

### **In type 1 diabetes**

Small doses of curcumin acts as anti-diabetic. The oxidative status and lipids level in the body is also affected by curcumin and its derivatives. Studies also prove that curcumin lowers the level of lipids in the liver and pancreas thus helping in maintaining blood glucose level. Studies also show an increase in plasma insulin 66.6% and reduction in plasma glucose level 27.5% conducted on rats (Aziz, El-Asmar et al., 2012).

By increasing insulin secretion diabetes interlinked symptoms, increased vision loss, wound healing, thirst, nerve damage and weight loss can also be overcome (Prasad, Gupta et al., 2014).

### **In type 2 diabetes**

Curcumin stimulates the beta cells activity in pancreas. Experimental study shows that it lowers the HOMA-IR level and increases the adiponectin level (Chuangsamarn, Rattanamongkolgul et al., 2012). Many studies suggest its potential for treating pre diabetic condition as well.

### **Anti-Hyperlipidemic agent**

Hyperlipidemic and low HDL cholesterol level (dyslipidemia) is the main cause of atherosclerosis and atherosclerosis-induced coronary heart disease. Herb Ayurvedic is helpful in management of Hypercholesterolemia and Metabolic disorder. Curcumin is helpful against the oxidation of cholesterol. Curcumin increases the HDL-C level and decreases lipid profile level. It is also effective in treating hypercholesterolemia. The acceptable daily intake of curcumin as an additive is 0–3 mg/kg body weight according to WHO, but it was well tolerated in human subjects in high doses as 12,000 mg/day. Curcumin improves lipoprotein metabolism by increasing HDL-C level and lowering TG and LDL-C in Rodent models (Bablani, Shamsi et al., 2016).

High density lipoprotein shows protective effect against cardiovascular disease (CVD) due to reverse cholesterol transport (RCT) process. Curcumin has been shown to improve lipoprotein metabolism in rodent models, by increasing HDL-C and reducing TG and LDL-C (Ganjali, Blesso et al., 2017).

### **Curcumin as a Hormetic agent**

Curcumin is known as Hormetic due to its biphasic dose response profile in reduction of stress response pathways. Hormesis is response phenomenon known by low dose stimulation and high dose inhibition. Curcumin acts as a hormetic agent and affects both endpoints predictive of metastasis and cell proliferation (Moghaddam, Oskouie et al., 2019).

### **Protective effect against Oral Lichen Planus**

Topical corticosteroids mostly used by oral lichens Planus (OLP) but it can cause mucosal atrophy and candidiasis. Administration or use of curcumin is helpful in treating lesions and OLP symptoms (White, Chamberlin et al., 2019). Curcumin helps to treat OLP and reduce

burning sensation and pain in combination with corticosteroids (Lv, Chen et al., 2019).

Recent research findings shows curcumin has positive effect in the treatment of oral lichen planus. In one research, 80mg of curcumin capsules were given to the patients and in result 80% patients had improved lesions, 10% patients were fully recovered and 50% had reduced pain (Kia, Basirat et al., 2017).

### **Protection against Ocular disease**

Curcumin has an impressive antioxidant effect by modulation of protective miRs in ocular disease caused by oxidative damage. Both retina and brain originate from the neural ectoderm; their degeneration may involve common deficits related epigenetic and genetic factors and miRs. The capability of curcumin is due to phytochemical effects on miRs (Momtazi, Derosa et al., 2016).

### **Protection against Ovarian Failure**

Premature ovarian failure is defined as decrease estradiol (E2) and increased follicle-stimulating hormone (FSH) levels accompany by the cessation of ovarian function women's under 40yrs (Cooper, Baker et al., 2011). Curcumin has shown regulation of enzymatic activity of enzymes detoxification like NAD(p)H is protective effect of curcumin against to Cyclophosphamide (CYC) also demonstrated on Rat and effects observed on Ra ovaries which also includes reduction in Lipid peroxidation, stimulate gene expression and antioxidant and anti-inflammatory effects also improving histological parameters (Melekoglu, Ciftci et al., 2018).

### **Benefits on cognition**

Chemically curcumin is polar and has low molecular weight which makes it capable of penetrating the blood-brain barrier (Patil, Tran et al., 2013). By maintaining cognitive function I also prevent the risk of neurodegenerative disease like Parkinson's and Alzheimer's. By stimulating the brain derived neurotrophic factors curcumin enhances the memory, brain function and reduces oxidative damage (Gomez-Pinilla, 2011).

### **Anti-oxidative property**

The capability to destroy oxidation of oxidative stratum such as genome damage in cells, amino acid, lipids and carbohydrates is known as antioxidant property or capability. Curcumin has become an important antioxidant due to its broad range and advantage in the

medical field. Curcumin is free radical scavenger and suppressor of genome damage, especially in presence of some ions like Fe and Cu (Mahdavi, Hadadi et al., 2017). Curcumin exerts antioxidant property by simulating the nitric acid (NO), peroxy nitrite (NOO), hydroxyl (OH) radicals, peroxy radicals (ROO) and reactive species by inducing and regulating antioxidant proteins (Samarghandian, Azimi-Nezhad et al., 2017). Curcumin's Antioxidant properties help in neutralizing the free radicals which leads to cell damage (Thangapazham, Sharad et al., 2013).

### **Protective effect against Kidney Disease**

Chronic renal failure is linked with high incidence of cardiovascular complications. Curcumin exerts antioxidant effects by sifting ROS directly and by inducing the expression of cytoprotective proteins in an Nrf2-dependent way. Indirectly curcumin intake also stimulates cardiac complications in some patients. Hemodialysis contributes to increase the production of free radicals and alleviates the antioxidant defenses in CRF patients (Correa, Buelna-Chontal et al., 2013).

### **Role in Pulmonary diseases**

Many diseases of respiratory origin are categorized by typical inflammatory responses, like asthma, COPD, acute liver injury, respiratory distress syndrome and pulmonary fibrosis. The special effects of curcumin on pulmonary fibrosis originate from its exploit on numerous pathways and through several contrivances. Curcumin, by bringing about a decline of TGF- $\beta$ 1 levels and TGF- $\beta$ 1 levels, cyclooxygenase 2 (COX-2) has a role in pulmonary fibrosis, led by inhibition of NF- $\kappa$ B, which results in anti-fibrotic and anti-inflammatory effects (Lelli, Sahebkar et al., 2017).

Allergic rhinitis (AR) is linked with an indicator complex categorized by rhinorrhea, nasal blocking, nasal itching, sneezing subordinate to IgE-mediated inflammation of the nasal mucosa. Curcumin significantly released the nasal symptoms, including itching, sneezing, obstruction and rhinorrhea, in AR patients. It also improved the nasal airflow (Wu and Xiao, 2016).

### **Immuno-modulatory Effect:**

Concept of curcumin in the immune falls into two categories of Innate and adaptive immunity. Innate immunity is defined as stereotyped rapid response well before the evolution of antigen-specific response provided by adaptive immunity. By regulating function of immune cells which also includes Neutrophils, Macrophages, B cells, T cells, natural killer cells and

monocytes, curcumin greatly affects immunity capability and enhances its function (Boroumand, Samarghandian et al., 2018).

### **Beneficial for Skin**

Curcumin promotes collagen deposition and exacerbates wound healing of skin. Curcumin is found to be operational in treating scabies, psoriasis, (Kang, Li et al., 2016) and dermatitis (Ternullo, Gagnat et al., 2019; Khan, 2019).

Due to anti-inflammatory and anti-cancer properties of curcumin, it shows beneficial effects in skin cancer. Recent studies show that curcumin inhibits the NF $\kappa$ B pathway and regulates the activity of pro-apoptotic protein. In melanoma cells it acts as an anti-proliferative agent and effective in skin cancer (Golchin and Ardeshiryajimi, 2018).

Curcumin shows effective results in the treatment of psoriasis. Recent studies show that curcumin acts as an anti-proliferative agent by activating pro-inflammatory cytokines *i.e.* tumor necrosis factor, interleukin-6 and 17 and interferon- $\gamma$ . Curcumin enhances the skin - barrier function by the activation of filaggrin and involucrin (iNV) (Di Nardo, Gianfaldoni et al., 2018).

### **Protection against neurotoxicity**

In developed and developing countries neurodegenerative disorders (NDDs) are becoming important health issues worldwide which are most common in old peoples (Kassebaum, Arora et al., 2016). Some diseases include in NDDs *i.e.* Parkinson's disease (PD), Huntington disease and Alzheimer's disease (AD) are still incurable (Abrahams, Haylett et al., 2019). NDDs are diagnosed by many micro processes observance of progressive neuronal dysfunction and death. This include mitochondrial dysfunction, specific protein accumulations, proteo-toxic stress, oxidative, nitrosative stress, and also linked abnormalities in proteasomal, lysosomal and ubiquitin systems, apoptosis, uncontrolled neuro-inflammation and excitotoxicity (Bagheri, Ghasemi et al., 2020).

Curcumin shows protective effects against chemical drugs like PTZ, SEVO, STNP and VCR whose overdose causes organ toxicities (Farkhondeh, Samarghandian et al., 2016).

Autophagy is critical for maintaining cellular homeostasis and is therefore constitutively active in many cell types. Studies have shown autophagy dysfunction as an important altruist for the pathogenesis of Parkinson's disease. Curcumin treatment alternates the pathology by lowering the mass of A53T  $\alpha$ -synuclein through the depletion of mTOR or p70S6K signaling and reposition of macro autophagy. Curcumin treatment points

many molecules and genes inside the autophagy pathway in order to put back autophagy in models of Alzheimer's disease (Forouzanfar, Read et al., 2020).

The use of platinum, cisplatin-base chemotherapeutic is linked with many adverse effects and is affecting the quality of life. Cisplatin therapy is threatened by many hurdles of resistance which stimulates the function capability of this drug. Curcumin shows beneficial effect to fight against cisplatin-resistant cancer cells and decrease its side effects like nephrotoxicity, neurotoxicity and ototoxicity (Rezaee, Momtazi et al., 2017).

### **Beneficial for blood clotting**

Ayurvedic medicines have been conventionally used in the treatment of cardiovascular disease and can help in modifying its progression, particularly in the coagulation process and hemostasis (Keihanian, Saeidinia et al., 2018)

Curcumin lowers the platelet accumulation in blood by lowering the formation of thromboxane that leads to stroke, deep vein thrombosis and pulmonary embolism. Curcumin acts as anti-thrombotic, anti-fibrotic properties. In different pathways *i.e.* PT, APTT and PT, it prolongs clotting time due to the hydrophobic group. Results show that BDMC and curcumin possess anti-coagulant activity and regular intake of turmeric helps to maintain anticoagulant status (Kim, Ku et al., 2012).

### **Anti-inflammatory property**

Curcumin is popular for its anti-inflammatory property which reduces chronic inflammation occurring in many health conditions like cancer, heart disease, arthritis, bowel disorder and diabetes. It has capability to block the function of the enzymes that donate in the inflammatory pathway (Khan, 2019). It discharges rheumatoid arthritis associated symptoms like pain, swelling, stiffness etc. (Chin, 2016). Following figure shows the mechanism of action by inhibition of various pathways.

### **Beneficial for Spinal cord injury**

Spinal cord injury (SCI) is a catastrophic event which extremely damages a patient's life, with extensive economic and social effects (Silva, Sousa et al. 2014). Recently, curcumin has appeared as a potential therapeutic drug in SCI therapy. Curcumin management could remarkably alternate edema of the injured spinal cord. Several studies have shown that curcumin applies a treatment effect in SCI by inhibiting oxidants, inflammatory reaction and protecting neurons (Zhang, Yang et al., 2016).

Curcumin protect against spinal injury by lowering the level of malondialdehyde and higher the level of serum superoxide dismutase in rats (Kavakli, Koca et al., 2011). In recent research, findings shows that curcumin reduce the level of malondialdehyde and increase the level of superoxide dismutase and glutathione peroxidase and thus prevent spinal injury (Akar, Ince et al., 2017).

### Role in Sepsis

Sepsis is known as life threatening state due to impairment of host immune response to infection (Al-Hasan and Justo 2019). The virtual role of curcumin in stimulating the immune response has shown changes in diseases *i.e.* rheumatoid arthritis, inflammatory bowel disease and metabolic syndrome in humans (Ghazimoradi, Saberi-Karimian et al., 2017). Thus, these effects can be observed in sepsis. Some studies show the simulation in therapeutic effects of *Curcuma Longa* on sepsis on cell lines and in animal models. Curcumin shows inhibitory effect on sepsis induced difficulty (Karimi, Ghodsi et al., 2019).

### Benefits against mental disorders

Curcumin helps in treatment of anxiety and depression by alleviating interlinked symptoms (Lopresti, Maes et al., 2014). Curcumin increase the level of fatty acid Omega-3 that motivates the development of brain (Brietzke, Mansur et al., 2013).

Preclinical studies shows curcumin intake is linked with increased level of brain derived neurotrophic factor (BDNF) (Motaghinejad, Motevalian et al., 2017). The effects of curcumin on neurocognition and BDNF is relevant for schizophrenia as well with levels of neurocognition shortage and lower level of BDNF is observed (Green, Matheson et al., 2011). Schizophrenia is linked with increased oxidative stress, abnormal neural pruning and inflammatory response (Barron, Hafizi et al. 2017), a therapeutic agent that stimulates one or more of them by increasing BDNF can protect processes like neuroplasticity, poor learning and memory influenced by the disease (Wynn, Green et al., 2018).

Autism Spectrum Disorder is multi-syndrome disorder which affects development of brain. Most common symptoms of ASD are less irritable nature, social interest, depression, aggression, sensory processing and epilepsy disease demonstrated as stereotypic behavior and repetitive. Curcumin also takes towards maintaining MMP-9 in blood mononuclear cells. Nervousness is one of the main causes of ASD. Curcumin is also helpful in drug molecule which is used in treatment of autism. Reportedly curcumin helps GABergic which is anti-anxiety hormone (Bhat, Mahalakshmi et al., 2019).

### Role in Gutmicro biota

Changes in intestinal micro biota are interlinked with many metabolic diseases which include diabetes, chronic liver diseases, obesity and the intestinal micro biota is suggested to be a new potential therapeutic target for these micro biota and linked diseases. Curcumin metabolism affects the abundance of many representatives in gut microbial communities of rats. By considering the increased number of studies which supports the pathogenic connection in between gut micro biota and in many diseases recently, especially the changes in many particular bacteria in diseases in the regulation of effects in gut micro biota which may contribute in part of therapeutic benefits of curcumin (Shen, Liu et al., 2017).

### Hepato-protective effect

Liver diseases alongside viral infection are spreading widely. Study conducted on the antiviral effect of curcumin rhizome extract HBV in HepG cells containing HBV genomes shows HBsAg secretion from liver cells without any cytotoxic side effects. It also decreases the level of mRNA production of HBV on infected cells and HBV residues production. Curcumin extract alleviates HBV duplication by increasing the level of protein p53 by enriching the protein stability and Tran's activation of p53 gene transcription (Tung, Nham et al., 2019).

Liver reperfusion or injury is one of the main problems of hepatic surgery and transplantation. Many studies suggest that curcumin is linked with liver improvement due to its anti-inflammatory property, anti-oxidative property and reduction of adhesion molecules capabilities. Oxidative stress is the major cause of liver damage. Curcumin targets these pathways involved in liver injury by increasing RNA scavenging and antioxidant enzymes and decreasing ROS (Bavarsad, Riahi et al., 2019).

Curcumin shows photodynamic therapy and increases the anti-neoplastic properties of curcumin in cancer cells (HC-AFW1, HUH6, HepT1 and HepG2) by stimulating the loss of viability through ROS production (Ellerkamp, Bortel et al., 2016).

### NAFLD

Nonalcoholic fatty liver disease (NAFLD) leads towards chronic liver injury, also linked with liver damage from steatosis to nonalcoholic steatohepatitis (Gheibi, Ghaleh et al., 2019).

### Alcoholic Liver Disease

By consuming alcohol daily (20g for female and 60-80 g

for males), risk for developing hepatitis and hepatic fibrosis increases (Samini 2018). Studies have highlighted the curcumin property as defensive agent for alcoholic liver disease. Supplementation of curcumin has capability of reducing inflammation, fatty liver and necrosis. Curcumin lowers oxidative stress and lipid peroxidation and also stimulates the NF- $\kappa$ B, and countenance of MIP-1, MIP-2, COX-2, IL-12, iNOS and TNF- $\alpha$  (Naksuriya, Okonogi et al., 2014).

### Role in metabolic syndrome

Metabolic disorder presents the connection of many metabolic disorders in a person at the same time period. Patients with inflammatory bowel disease (IBS) have common symptoms of abdominal pain and flatulence, which may help to change the habits interlinked to alleviated frequency of defecations. Curcumin clears the liver from many harmful metabolites, curcumin is also known as a natural painkiller, it maintains the metabolism activity and is also helpful in weight loss. Curcumin has a therapeutic antifibrotic effect which is the treatment of liver fibrosis (Selmanovic, Beganlic et al., 2017).

Curcumin supplementation (1 g/day for 30 days) is also effective on dyslipidemia in the patients with obesity which leads towards the significant stimulation in serum TG concentrations. Studies have confirmed the efficacy of curcumin supplementation in significantly reducing HbA1c of person with non-alcoholic fatty liver disease, BMI, liver fat content, LDL, total cholesterol, glucose level and Metabolic syndrome (Azhdari, Karandish et al., 2019).

### Side effects of curcumin consumption

Excess curcumin consumption leads to Low glucose level, Bleeding related diseases, Menstruation increase level and also low fertility. It can also lead towards anemia. Its overdose may leads to abortion and excessive uterine contraction (Kunnumakkara, Harsha et al., 2019).

Other effects are linked with headache and gastric problems (diarrhea and nausea), rash increase in lactate dehydrogenase amount and serum alkaline phosphatase (Asher and Spelman, 2013). Mild gastric symptoms (such as meteorism, dyspepsia, gastric reflux and bloating), constipation, loose stool, constipation and hot flashes may also occur (Yang, Akbar et al., 2019).

### CONCLUSION

In conclusion, Curcumin helps to reduce the oxidative stress by acting as a free radical and anti-oxidant. As a result, it helps in recovery from many acute and chronic

diseases *i.e.* arthritis, diabetes, diabetic micro-angiopathy, diabetic nephropathy, psoriasis, gastro-Intestinal diseases, acute cardiac diseases, anxiety, hyper-lipidemia, liver disease, bacterial infection and inflammation. For a household ingredient of many South Asian houses, it has a lot of therapeutic potential.

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