International Journal of Pharmacy and Herbal Technology

e-ISSN: 2583-8962 Vol. 2, Issue 4 (October – December, 2024) pp: (2461-2475)

Review On: Multifunctional Medicinal Properties of Turmeric

Shreya Shinde, * Sanjay K. Bais
Fabtech College of Pharmacy, Sangola, Solapur, Maharashtra, India
*Corresponding Author: shreyashinde791@gmail.com

Received Date: November 26, 2024; Published Date: 13 December,2024

Abstract

Turmeric (Curcuma longa), a plant known for its healing properties, owes much of its benefits to its active ingredient, curcumin. This ingredient has many health benefits, including reducing inflammation, fighting oxidation, and acting against bacteria and cancer. It also helps protect the brain. Curcumin works by targeting different molecules in the body, such as cytokines and enzymes, to create these effects. However, one challenge is that curcumin is not easily absorbed by the body, so scientists are exploring ways to improve its absorption, such as using nanoparticles.

This review also looks at current clinical studies, the potential of turmeric in modern treatments, and its traditional uses. In Indian, Pakistani, and Bangladeshi medicine, People have been using turmeric "for many years to help with different conditions. This root, especially the rhizome, is the most commonly used part of the plant. It's prepared in different ways, like with warm water, and is used for conditions like asthma and coughing. In Ayurveda medicine, turmeric is considered a "rasayana" plant, meaning it can help slow down aging. This review aims to give a full picture of turmeric's medicinal value and inspire further research.

Keywords - Ayurveda, Curcumin, Rasayan, Rhizome, healing properties.

INTRODUCTION

The herb turmeric, also called A perennial is Curema longa. plant that's been around for a while and plant that has long been in use and is native to India. It belongs to the Zingiberaceae family. Over time, turmeric has been improved through selection and cross-breeding. Today, there are over 100 recognized species in the Curcuma genus with common ones being Curcuma longa, Curcuma aromatic, and Curcuma xanthorrhiza.

This biologically active compounds Curcuma species differ between species and even within the same species. These plants also show noticeable differences in their above-ground leaves and flowers, as well as in the properties of their underground rhizomes. [1]

(Curcuma longa) Turmeric

Turmeric comes from Curcuma longa, a perennial herb with rhizomes that is indigenous to tropical regions of South Asia as well as Belonging to the Zingiberaceae family, which includes ginger. There are currently 133 known species of Curcuma in the globe. Nearly everywhere in India, where food is highly regarded and given significance for both its medicinal qualities and richness flavor, adding fresh roots is the only way to successfully finish any recipe of this amazing herb known as "turmeric." Each plant has a therapeutic use, and they can be used by itself or mixed with other herbs to help treat conditions affecting the head, feet, and stomach. This review sheds a lot of light on turmeric's enigmatic medicinal qualities. [2]

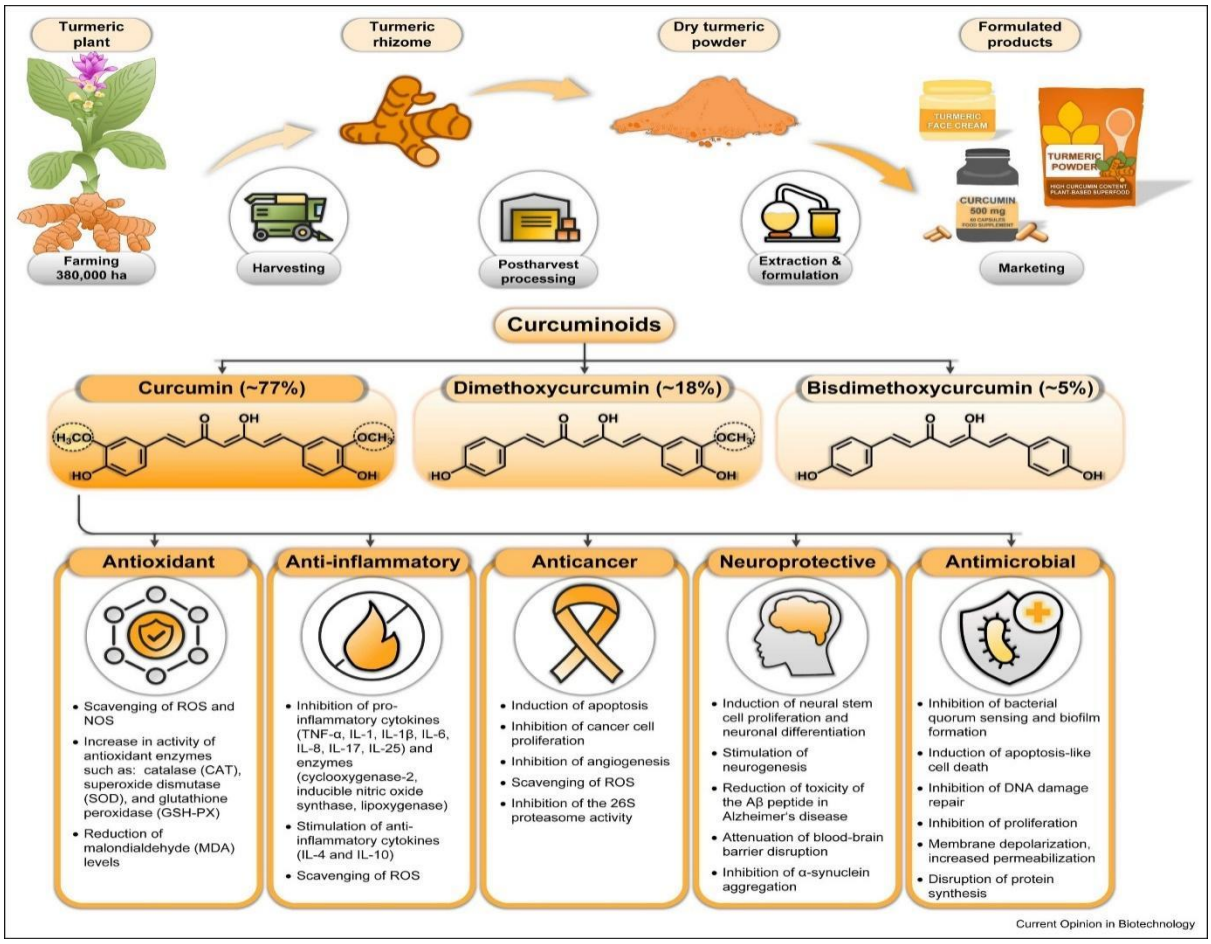

Figure 1*: *Description of Turmeric

The molecules curcumin affects and its chemical structure

Turmeric's chemical makeup includes comprises It has 23.1% moisture, 69.4% carbs, 3.5% minerals, 5.1% fat, and 6.3% protein. It is commonly known as "Haridra" or "Haldi." When the rhizomes are steam-distilled, they produce A vital oil makes up 5-8%. that contains compounds like α-phellandrene (1), sabinene It contains 53% sesquiterpenes, 25% zingiberene, 1% borneol, and 0.6% cineol.53% sesquiterpenes, 25% zingiberene, 1% borneol, and 0.6% cineol.[3]

The main active ingredient Curcumin is found in turmeric, which gives turmeric its yellow hue and is responsible for much of its. medicinal benefits. Curcumin Accounts for roughly 2–5% of turmeric. There are also two other Curcuminoids found in turmeric include desmethoxycurcumin and bisdesmethoxycurcumin. Curcumin was initially separated from 1815 turmeric and its composition and its structure, called diferuloylmethane, was identified in 1910. Today, most turmeric supplements contain around 77% diferuloylmethane, 18% desmethoxycurcumin, and 5% bisdesmethoxycurcumin. [4]

Turmeric provides various health advantages in everyday life, including

It can be used as a natural antiseptic and antibacterial agent to treat burns and cuts.

When combined with cauliflower, it may help protect against prostate cancer and stop its growth. In research on animals, has been demonstrated to avoid lung cancer growth in those with breast cancer.

It may cause melanoma cells to destroy themselves, stopping the disease from spreading. It helps lower the likelihood of leukemia in children.

Acts as A natural cleanser for the liver.

It Could assist in preventing Alzheimer's or Reduce its progression. by clearing amyloid plaque from the brain.
It could help stop the spread of Cancer spreading to other areas of the body.
Turmeric Serves as a strong anti-inflammatory and can work Along with some Medications that reduce inflammation.
It may support Breakdown of fat and help with weight control.
In Chinese traditional medicine, this has been utilized to address depression for a long time.
Turmeric's The anti-inflammatory properties of qualities make it a natural remedy for arthritis and other inflammatory conditions.
It can reduce the side effects and improve the effectiveness of the chemotherapy drug paclitaxel.
Studies show turmeric may help prevent pancreatic cancer.
Research is ongoing on turmeric's benefits for multiple myeloma.
This has been found to prevent the development of new blood vessels within cancers
Turmeric Supports injury recovery and helps regenerate tissue harm.
It Could aid in treating psoriasis and other inflammatory skin disorders. [5]

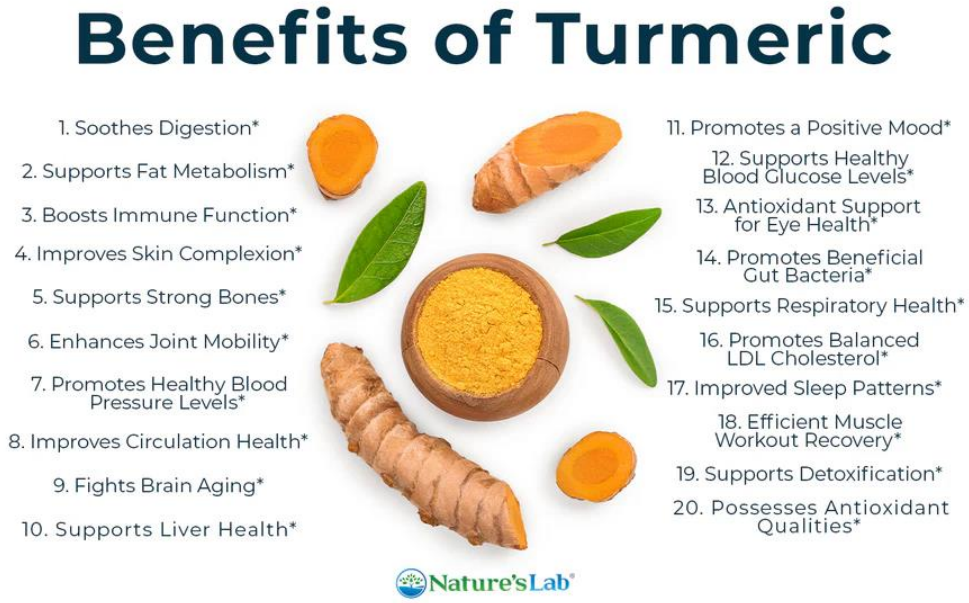

Figure 2*: *Benefits of turmeric

Investigation of Curcuma longa extracts in vitro

In an in vitro investigation into extracts with Curcuma longa (turmeric), identical to a study carried out by Negi et al. (1999) that found turmeric's ethanol and hexane extracts effective against Staphylococcus aureus, all extracts from turmeric rhizome showed inhibitory effects, with zones of inhibition ranging from 9 mm to 21 mm. These extracts were tested against both standard and clinical strains of *S.* aureus. The methanolic extract was the most effective, creating a 50 mg/ml created a 19 mm harmful area, whilst the dose of benzene extract was the least effective, showing a 9 mm zone of inhibition at the same dose.

The study also looked at the minimum inhibitory concentration (MIC) of the extracts at different dilutions (1/10 and 1/100), and the activity levels were compared to standard antibiotics. As the extract was diluted, its effectiveness decreased. The inhibition percentages were measured for various extracts when compared to a clinical isolate of S. aureus ATCC 6571. The results were: petroleum ether extract showed 73% to 63% inhibition, benzene extract showed 84% to 68%,

chloroform extract showed 42% to 31%, methanol extract showed 100% to 84%, and the aqueous extract showed 73% to 57%. [6]

Microorganism	***Staphylococcus aureus* (SR) zone of inhibition**		***Staphylococcus aureus* (CI) zone of inhibition**	
Name of drug	**In mm mean**	**As percentage**	**In mm mean**	**As percentage**
Gentamycin 30 mcg	25	100	20	100
Fraction-I (petroleum ether)	20	73	18	85
1/10 Dilution of fraction-I	18	63	17	92
1/100 Dilution of fraction-I	18	63	17	92
Fraction-II(benzene)	22	84	21	107
1/10 Dilution of fraction-II	20	73	19	92
1/100 Dilution of fraction-II	19	68	16	71
Fraction-III(chloroform)	14	42	16	71
1/10 Dilution of fraction-III	13	36	15	64
1/100 Dilution of fraction-III	12	31	14	57
Fraction-IV(methanol)	25	100	12	42
1/10 Dilution of fraction-IV	23	89	10	28
1/100 Dilution of fraction-IV	22	84	9	21
Fraction-V(aqueous)	20	73	18	85
1/10 Dilution of fraction-V	18	63	17	78
1/100 Dilution of fraction-V	17	57	15	64
Ethylene glycol	6	00	6	00

Table 1: Minimum Inhibitory Concentration of Different Fraction of Curcumin Longae on Gram – Positive Bacteria with Gentamycin as a Standard Reference

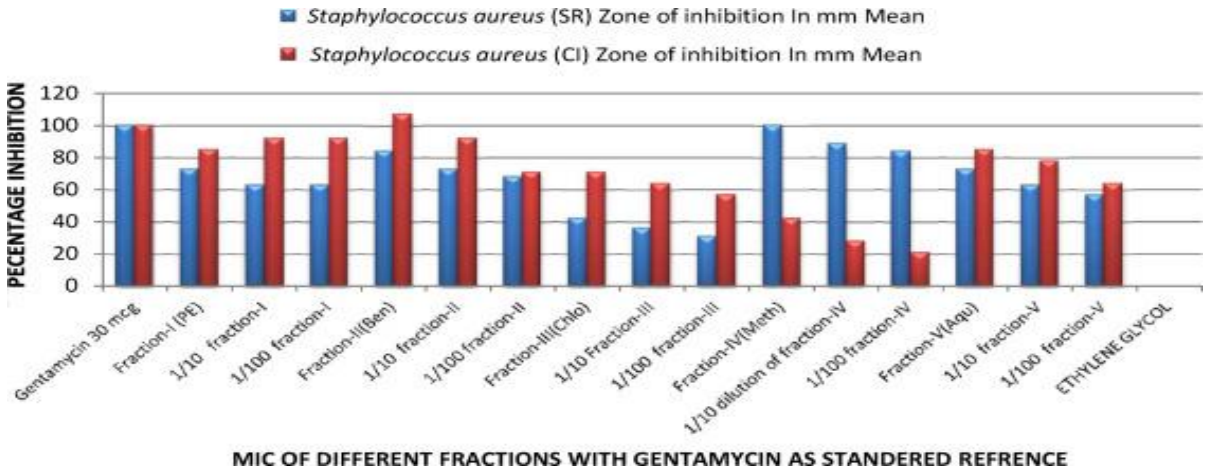

***Figure 3*:** *Mic Of Different Fraction with Gentamycin as Standard Reference*

Fig. 3. Schematic demonstration of the smallest inhibitory doses of several Curcuma longa fractions regarding gram-positive microorganisms employing Gentamycin as a point of comparison

The investigation that assessed antibacterial activity Efficiency Curcuma malabarica and C. zedoaria root extracts towards six strains of bacteria supported this aforementioned conclusion. For C. zedoaria, the MIC values varied from a while for C. malabarica, C. malabarica inhibited Gram-positive S. This aureus, whereas C. zedoaria did not. This investigation was the first to document C. Malabarian's antibacterial capabilities. The results also provide credence to the traditional medicine's use of C. azedoaria tubers to treat bacterial and fungal diseases. Observations made when assessing the Especially the Staphylococcus aureus clinical isolate showed a greater degree of sensitivity toThe antimicrobial effect of rhizome extracts from C. longa.

The bacteria's behavior before receiving application of C. longa extract was ascertained by electron microscopy. After being in a solution with zero microliters of C. longa extract for twenty-four hours, the cells displayed the typical S. aureus morphology, involving a surface having several layers. made up Its epidermal epithelium. On the other hand, after being heated to an amount of 55 µl concentration (0.5 g/ml) of extract from C. longa for a full day, the cells displayed different stages of the cell death process. which signify a period of the disruption of mitochondria intermediate, where A small amount of the cell membrane and plasmolysis to occur are noted. At this point, the cytoplasmic membrane is partially absent from the cell, and the outer membrane structure appears undamaged. The cell has a distorted shape. [7]

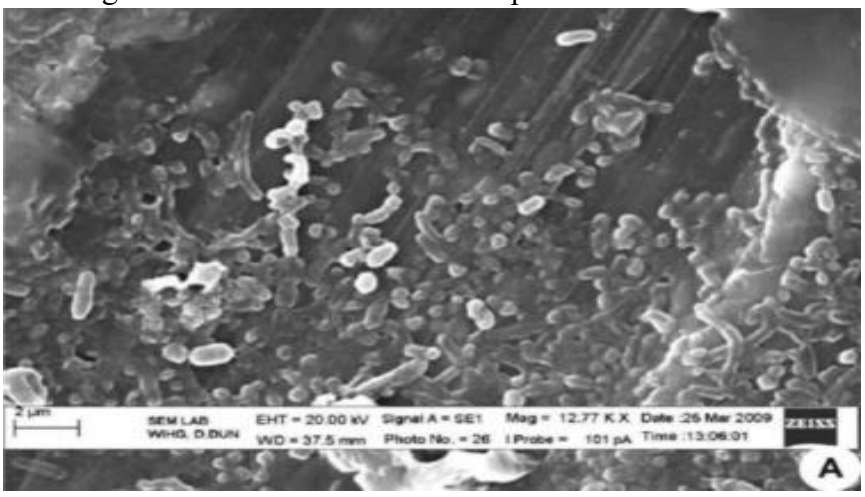

***Figure 4*:** *Staphylococcus aureus is a bacteria neglected*

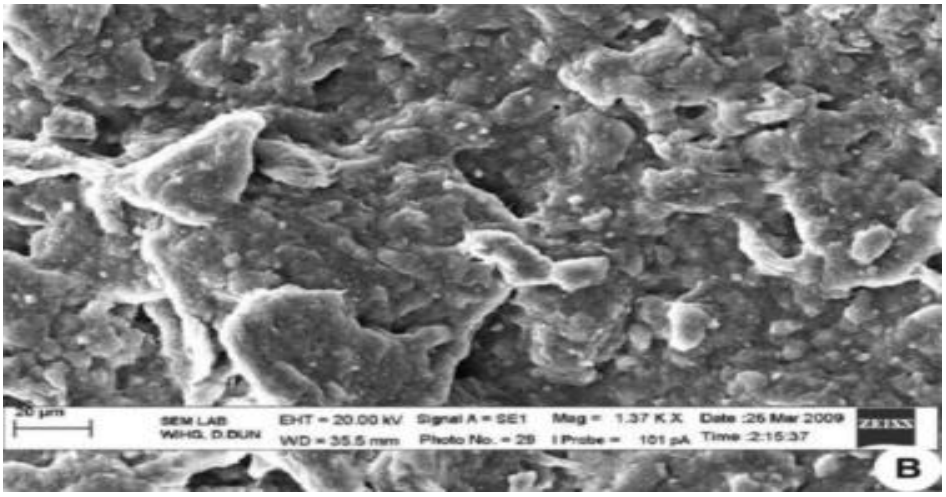

Figure 5**:** *Partial membrane damage has been demonstrated by the presence of Staphylococcus aureus supplemented with an active ingredient from Curcuma longa*

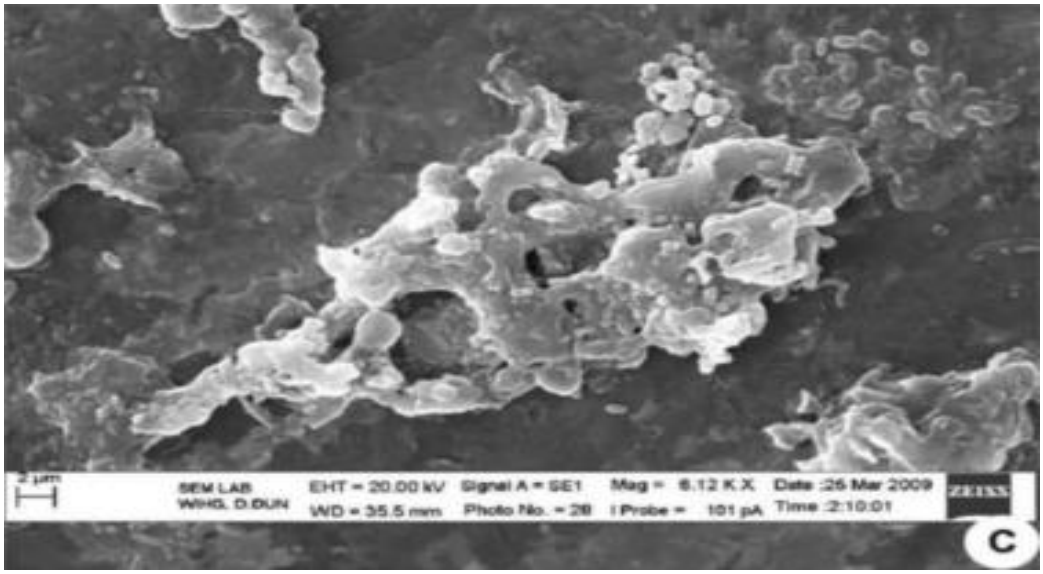

Figure 6**:** *When a naturally occurring, active chemical is added to Staphylococcus aureus, the bacterial cells' cytoplasm typically leaks out.*

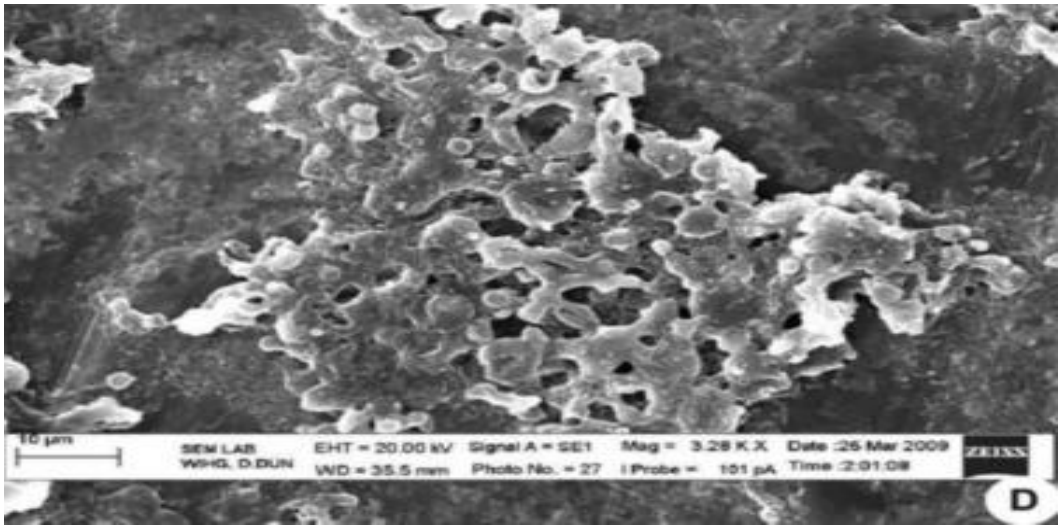

Figure 7**:** *Total destruction of membranes is shown by the presence of Staphylococcus aureus combined with an active component via Curcuma longa*

The phytocomponents of turmeric

13.1% moisture, 5.1% fat, 6.3% protein, 3.5% minerals, and 69.4% carbohydrates all have been contained in turmeric. The crucial oil, which makes up 5.8% of turmeric and is obtained through steam distillation, includes 53% these compounds, 0.6% sabinene, 1% phellandrene, and 1% zingiberene 1 percent cineol, with 0.5% borneol as. Curcumin (3–4%), which comprises a combination of Turmeric's yellow color is caused by curcumin I (94%), curcumin II (6%), and curcumin III (0.3%). tint.

Additionally, curcumin affects variations of curcumin, like bisdemethoxycurcumin and demethoxycurcumin. Curcumin melts at 176–177°C and dissolves in substances like acetic acid, ethanol, alkali, ketones, and chloroform, producing a reddish-brown salt when mixed with them. The rhizomes also contain other compounds, such as mono- and di-demethoxycurcumin, curzerenone, curdione, and tumerone A and B. In addition, investigations are being done with the use of essential oils. found in this leaves Curcuma longa, including a new type of sesquiterpene. [7]

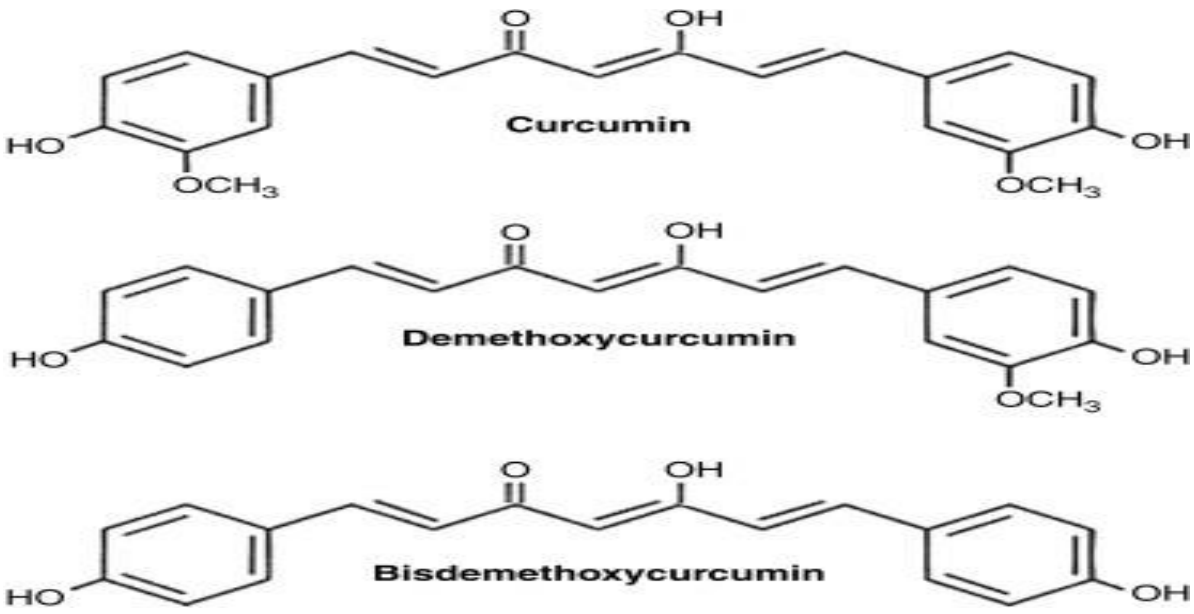

***Figure 8*:** Structure *of curcumin*

hydroxyphenyl-2-methyl-6-Two novel bisabolane sesquiterpenes, two s4-formylphenyl -2-methyl-6-Two calebin derivatives: 2-2-hepten4-one- 2-oxo-3-butenyl3-(Chloromethylphenyl) and 4"-(4"'-hydroxyphenyl3"'-methoxy)4"-(4"'-hydroxyphenyl) propenoate- 2-oxo-3-bute the compound It has been found that nyl-3-(4'-hydroxyphenyl-3'-methoxy) using turmeric Five additional bisabolane these substances have been found to exist as well., including propenoate

Gastrointestinal Effects

Turmeric has several benefits for the digestive system, offering protection against injuries. In experiments with mice, turmeric helped prevent ulcers caused by stress, alcohol, and other triggers. It works by increasing mucus production in the stomach, which protects the stomach lining. Turmeric also reduces intestinal spasms and increases the production of gastrin, bicarbonate, pancreatic enzymes, and secretin, which help digestion.

In a phase II study with 25 patients who had stomach ulcers, they were given Consume six hundred milligrams of turmeric powder at least five times a day. After the treatment, 48% of the patients had fully healed from their ulcers, with no negative side effects or abnormal blood test results. In mice with induced colitis, synthetic curcumin treatment significantly reduced damage to the gut

lining Following delivering fifty milligrams per kilogram of curcumin, it lowered inflammation, lipid peroxidation, neutrophil activity, and diarrhea, even though colitis was still induced. All signs of inflammation went down, and patients also reported feeling better. Curcumin has also been shown to reduce inflammation in mouse models of pancreatitis.[8]

Antidiabetic characteristic

A study from Auburn University in 2009, published in Biochemistry and Biophysical Research Communications, looked at turmeric supplements and their potential to help reverse diabetes. It found that curcumin, a key compound in turmeric, stimulates AMPK, making it 400 times more effective at boosting insulin production than metformin, a common diabetes medication. This research suggests that turmeric may increase reactivity to glucagon and reduce the symptoms type 2 diabetes.

The research of Singlet (2010) asserts that curcumin has been scientifically proven to increase glucose concentrations in rats, prevent insulin-dependent eye problems (retinopathy), reduce cholesterol issues (dyslipidemia), and ease nerve pain caused by diabetes, all while lowering blood sugar levels. Vyas (2015) also noted that curcumin can protect people avoiding type 2 diabetes for people with prediabetes. Based to a Thai study that was published in Diabetes Care, those with hyperglycemia Curcumin users were less likely to acquire compared to individuals without type 2 diabetes. Here it is due to turmeric's ability to prevent type 2 diabetes and lower insulin resistance. Experimental research indicates that turmeric may help diabetics minimize cerebrovascular damage, or damage to tiny veins, rather than lowering blood sugar levels overall. (Nair, 2013). [9]

Figure 9*: *Curcumin

Disorders of inflammation and edema

An effective anti-inflammatory compound that which has been as an specifically block the enzymes lipoxygenase and COX-2. Studies on animals, both in living organisms (in vivo) and in lab settings (in vitro), have proven its ability to reduce both short-term and long-term inflammation. In mice, doses of curcumin between 50 and 200 mg/kg were enough to prevent swelling. Curcumin was 48 mg per kilogram of total body weight lowered inflammation by 50%, therefore being almost as efficient as cortisone and phenylbutazone..

In rats, paw swelling and inflammation decreased with smaller doses of 20–80 mg/kg. Additionally, curcumin prevented arthritis in rats caused by formaldehyde when given 40 mg/kg amount, and even at a daily dose of no less than 2 g/kg were used, there were no signs of toxicity.

In another in an animal experiment, a condition called rheumatoid arthritis was brought on by streptococci bacteria. When rats were given extract of turmeric containing four milligrams of curcuminoids as per kg of body weight for four days before the arthritis began, inflammation was reduced by 75% in the early stages and 68% in the chronic stages. A different test using an oral preparation of curcuminoids given four days before arthritis showed a 48% reduction in joint inflammation. [10]

Cancer

The anticancer effects of turmeric have been widely researched, but the findings are still in the early stages. Conventional medicine remains the best treatment for cancer. However, many studies suggest that curcumin, a key component of turmeric, may have benefits in cancer treatment. It could affect the processes of cancer cell formation, growth, and spread at a molecular level. Curcumin is considered a strong anti-cancer agent and provides considerably to triggering apoptosis which is crucial in preventing the development of cancer cells in rats and other models. Curcumin can halt the cell cycle, which helps stop cancer development without inhibiting the synthesis of prostaglandins. It has been shown to inhibit breast cancer through various mechanisms. Additionally, curcumin can suppress the growth of certain blood cells and leukemia cell lines.

Nitric oxide (NO) and its byproducts are important in promoting tumor growth, and it was recently determined that turmeric enhances NO manufacturing. in natural killer (NK) cells following extended therapy, enhancing its tumor-fighting effects.

Recent research has also revealed interesting findings regarding curcumin's ability to trigger cancer cells in the human colon to undergo apoptosis, particularly involving heat shock proteins (HSPs). In this study, researchers introduced the hsp 70 gene into certain cells that cause colon cancer to test their curcumin sensitivity. They discovered that curcumin didn't cause death in cells with hsp 70, but cells lacking this protein were highly sensitive to curcumin-induced apoptosis. This was evidenced by changes such as nuclear condensation, mitochondrial membrane potential alterations, Cytochrome C production and protease three and nine stimulation, among other apoplectic indicators. [11]

Antimicrobial Activity

The presence of essential oil of turmeric with many parasites and harmful fungus inhibits their growth. Longa curcuma. An analysis of chicks that is harboring a caecal parasite infection. The Eimera Maxima demonstrated that diets enhanced with Turmeric promotes enhanced weight gain and a decrease in small intestinal lesion scores. According to a different study, topically administered dermatophytes, inhibited by turmeric oil, and hazardous mushrooms when guinea pigs were either harmful bacteria or dermatophytes yeast or molds. After seven days following the use of turmeric treatment, the guinea pigs with dermatophyte and bacterial infections had no additional symptoms. It has been noted When utilizing Curcumin for mild measures used to combat Plasmodium falciparum and Major organisms of Leishmania. [12]

Activity of antioxidants

Its main ingredient, turmeric, is frequently regarded as the strongest antioxidant ever discovered. The antioxidant activity of turmeric and the fat- and water Its turmeric component's aqueous compounds are akin to those of both C and E vitamins. The main mechanism underlying turmeric's hepatoprotective properties is its ability to avoid the creation of cytosine that encourage irritation. By reducing oxygen content cells, curcumin shields them from free radicals' harmful effects. When it comes to scavenging superoxide anion, Purified turmeric is more successful than demethoxycurcumin and a compound called bis. It lowers the risk of high blood pressure, macular

degeneration, cataracts, glaucoma, heart disease, In addition to elevated cholesterol levels. Curcumin Ryudai Gold (RD) has strong scavenging properties and a high phenolic and flavonoid content. As soon as the extraction process temperature is properly high, the content of curcuminoid increases, hence increasing antioxidant activity. Ninety°C is ideal for strong antioxidant capabilities. It stays at 90°C for 60 minutes. Antioxidant activity and the amount of curcuminoids were reduced by extreme heat treatment. Turmeric extract is not peroxidized by hydrogen peroxide, protecting lipids and red blood cells. Oxidative damage is avoided and DNA binding by hazardous metabolites is decreased. Pro-oxidant to turmeric is a strong bioprotectant with many beneficial effects when transition metal ions are present. (Cu and Fe). This treatment effectively neutralizes ROS, including nitric oxide. Turmeric peels have a higher phenol content than the powder. Addition of ginger peels reveals a high phenolic content. Peels have a higher antioxidant activity than the commercial powder version as a result.[13]

Activity for wound healing

The use of topical curcumin extracts to diabetic rats' skin lesions showed A development in Mechanism of operation: - A rise in beta levels was part of the repair action mechanism. transforming growth factor together with an uptick in nitric oxide synthase activity. Turmeric's ability to heal wounds has been extensively researched, and results have shown that its local application works well. Since the beginning, Chinese medicine has been employing it for this purpose. Turmeric extract is a useful component in cosmetic formulations that promote regeneration because of this effect. [14]

Hepatoprotective Factors

Jaundice has long been treated traditionally with a mixture of amla juice and turmeric rhizome powder (Pandey, 2002). Curcumin, the main antioxidant found in turmeric rhizome extract, has shown promise in promoting apoptosis in injured hepatocytes. This defensive measure is connected to the inhibition of inflammation and fibrogenesis in the liver. The ethanolic C. longa rhizome extract was administered at the hepatoprotective impact of 250 milligrams per kilogram and 500 mg/kg concentrations has been observed to be significant and dose-dependent. Furthermore, C. longa's volatile oils and curcumin have strong anti-inflammatory qualities. [15]

Neuroprotective benefits

Curcumin may be useful in treating cerebrovascular illnesses and protecting the brain. because of its powerful anti-inflammatory and antioxidant qualities. Zhang et al. investigated how curcumin prevented TNF-α-induced HUVEC damage. The results demonstrated that although the morphology of HUVEC treated with curcumin did not change dramatically, the quantity contains cells that have died did, possibly as output of downregulating the expression of the caspase-3 gene. Susana et al. investigated how curcumin prevented rats' cerebellar granule neurons (CGNs) from dying after hemin was administered. According to the study, curcumin may enhance Glutathione-S's actions the glutathione reductase (GR), glutathione transferase (GST), and SOD activities in CGNs, as well as Die heme peptidase expression-1 (HO-1), glutathione transferase (GSH), and oxidized glutathione disulfide (GSSG) in CGNs and cause to go into the nucleus, where it will function as a neuroprotective factor. Depression is a type of psychological illness marked by profound, protracted sadness and disinterest. The illness has a major negative impact on quality of life, and there has been an increase in depression cases recently. In a Mouse model for acute, unexpected, and moderate stress (CUMS)-induced depression, Zhang et al. investigated the antidepressant benefits of turmeric. According to findings, curcumin may block BDNF, or brain-derived neurotrophic factor. The lateral amygdala (LA) may exhibit improved depression behavior if Synaptophysin (SYN) and Expression of synaptic density protein 95 (PSD-95) is decreased.

This provides a new avenue for the clinical treatment of depression. Further research on curcumin's impact on CUMS depression in a rat model and its potential protection of the central nervous system against chronic stress in rats. The study revealed that the rats given curcumin had a greater preference for sugar water, a shorter immobility period, a significantly lower serum corticosterone level, a significant increase in PSD-95, SYN protein, and BDNF are expressed in the hippocampus, a significant decrease in the apoptosis index in tissue sections, and a reduction in depression-like behavior. It demonstrated curcumin's possible antidepressant impact, which may be linked to enhancing neural plasticity, reducing blood cortisol levels by regulating the hypothalamic-pituitary-adrenal axis, and preventing apoptosis.

Yang et al. investigated curcumin's neuroprotective properties in a model of rodents that heavy impact-induced Acute brain damage (TBI). The results of the experiment demonstrated that the The curcumin therapy group experienced a substantial decrease ($P < 0.05$).the modified neurological impairment scale score, The results of the trial shown that curcumin may considerably improve the nerve function of TBI-affected rats. The mechanism underlying this improvement may be autophagy, which is triggered by the route of PI3K/AKT activation. PI3K/AKT activation level increased dramatically, and autophagy was observed in this experiment, although the protein associated with the PI3K/AKT signaling pathway did not alter significantly. Thus, more research is needed to determine the exact mechanism triggering the signaling pathway between PI3K and AKT.[16]

Carcinogenesis of skin

Applying a topical mixture of curcumin and giving female CD-1 mice the tumor promoter TPA twice a week for 20 weeks. significantly reduced the development of papillomas (66). In a separate investigation, the use of curcumin at relatively low topical dosages (20 or 100 nmol) significantly inhibited the tumor promotion generated by TPA. Topical administration ofeither demethoxycurcumin or pure curcumin, rapport-related equipotent inhibitory effects TPA were shown by commercial-grade curcumin, composed of roughly 3% bis-demethoxycurcumin, 17% demethoxycurcumin, and 77% curcumin. -caused mice got tumors when given DMBA-induced tumor development. Additionally, dietary supplementation of 2% turmeric effectively reduced the growth of skin tumors produced by TPA and DMBA. In a two-stage skin tumorigenesis model induced by benzo[a]pyrene and stimulated by TPA, curcumin lowered both the number of tumored mice and the number of tumors per animal. Later research conducted by Huang et al. demonstrated that curcumin protected mouse skin towards UV-induced dermatitis.[17]

Curcumin's market potential and applications

Curcumin is being used in a number of applicationsin the pharmaceutical, food, and industries for cosmetics after gaining the widely accepted safe (GRAS) grouping fromThe Food and Drug Administration of the United States. Due to intensive research efforts, curcumin's market relevance and commercial worth have grown substantially in recent years. Curcumin is sold in the food business under the names E100, CI 75300, Natural Yellow 3, and diferuloylmethane. Typically used indairy products, baked foods, enhances the generation of singlet oxygen superoxide and other reactive oxygen species yellow coloring. Curcumin is therefore a more beneficial and safe replacement for artificial yellow hues. Due to curcumin's pH-dependent color shift, food deterioration has been studied utilising curcumin as a pH biosensor.

Curcumin's antibacterial and anti-inflammatory properties have piqued interest in its ability to extend food shelf life. Green foods are also preserved with it. Surprisingly when curcumin is exposed to visible light at 400–500 nm, it becomes photoactivated and increases the production of reactive oxygen species, such as singlet oxygen, superoxide anions, and hydroxyl radicals. As a

result, common food pathogens like Salmonella typhimurium, Listeria monocytogenes, Listeria innocua, Escherichia coli O157:H7, and Staphylococcus aureus develop less readily in fresh meat when these factors are present. Furthermore, curcumin deactivates the enzymes that cause browning and deterioration in fruits, including Aspergillus flavus in maize kernels, Penicillium expansum in cucumbers, and Botrytis cinerea in apples, and it prevents the formation of food-borne fungus.

Curcumin is a chemical that promotes well-being and has medicinal properties. According to recent studies, curcumin prevents and fights against viral and noninfectious diseases like diabetes, Parkinson's disease, TB, malaria, Alzheimer's disease, and cancer. It also reduces inflammation. Curcumin also facilitates the healing of injuries and helps to properly modulate the immune system, which opens up a range of uses for therapy. The PubMed database shows that since 2019, 268 clinical studies including curcumin have been conducted. These investigations showed curcumin's numerous health benefits and underscored the compound's vast potential. For instance, oral curcumin therapy dramatically decreased blood levels of islet amyloid polypeptide, knee injury and osteoarthritis outcome ratings, and the formation of prostate-specific antigen, a biomarker for prostate cancer (18).

Prospects for the future

Since ancient times, ayurvedic medicine has employed turmeric for a variety of biological purposes. While considerable research has been done on potential medical uses, no studies for medication development have been conducted as of yet. Despite the fact that the raw extract has several therapeutic applications; however, clinical applications can only be made following substantial studies on its toxicity, pharmacotherapeutics, mechanism of action, and bioactivity. But since Now that curcumin is available in its purest form and demonstrates a wide spectrum of biological actions, developing new drugs would be easier. substance following comprehensive research on the drug's pharmacological properties and mode of action. Preclinical and Clinical research on curcumin has shown that it is both effective and safe for the treatment of cancer. The limited availability of curcumin has impeded its effectiveness and safety. A number of variables, including low serum levels, tissue dispersion, short half-lives, and quick bodily clearance, restrict how much can be adequately concentrated in the tissues.

Its poor bioavailability has been addressed by a number of approaches, which involve the simultaneous administration of medication and liposomal formulations of curcumin.

It has been discovered that certain curcumin analogues increase its biological activity. Still, Future research is probably going to concentrate on gaining more insight and understanding of novel techniques, such as phospholipid complexes, liposomes, and nanoparticles for the delivery of curcumin by several ways. Trials in the future ought to feature carefully designed pharmacodynamic research. Certain data indicates that chronically administering high doses of curcumin to animals may cause tumor development. While there have been few adverse effects observed in Phase I short-term clinical trials and animal research, long-term, extensive, and Human randomized clinical trials are required to confirm curcumin's safety at Doses of antioxidants and agents that reduce inflammation. Additionally, these clinical trials are required find best dose, bioavailability, and bio efficacy for medications based on curcumin. The One of the biggest challenges is creating curcumin-based medications with sufficient scientific proof to the world community. A medication that works well should have low toxicity, sufficient absorption, and appropriate excretion, metabolism, and distribution, and ought to be able to manage the targeted illness with effectiveness and specificity. [19]

Increasing the bioavailability of curcumin

The body's high metabolic rates, quick clearance and elimination, inactivity of metabolic products, and poor gastrointestinal absorption all contribute to a pharmacological agent's low bioavailability. Curcumin is very hydrophobic due to its chemical categories, large molecular weight, and tautomeric structure; as a result, the gastrointestinal epithelium can only absorb it partially. Following an oral dosage of 1 g/kg in rats, nearly undetectable plasma curcumin levels were found, according to one of the first studies to disclose this restriction. Around 99% of plasma curcumin is formed by the liver's primary metabolism of curcumin, which results in glucuronide and sulfate conjugates. It has been reported that the bioactivity of these metabolites is lower than that of free curcumin. Finally, curcumin's short half-life is a major factor in its limited bioavailability. Around 99% of plasma curcumin is formed by the liver's primary metabolism of curcumin, which results in glucuronide and sulfate conjugates. It has been reported that the bioactivity of these metabolites is lower than that of free curcumin. Finally, curcumin's short half-life is a major factor in its limited bioavailability. Orally administered curcuminoids in rats possess a peak plasma concentration of 0.83 ± 0.05 and an elimination half-life of 1.70 ± 0.58 hours. hours. Clinical trials showed a 29-fold reduction in normal curcuminoid combination absorption as compared to Meriva. But 95% of the curcuminoid powder in the C95 formulation boosted bioavailability fivefold. It is claimed that the bioavailability of the curcumin cyclodextrin complex (CCC) is 45 times greater than that of C95. The bioavailability of the curcuminoid phospholipid complex (CPC) was shown to be thirty times stronger than turmeric and twenty times more potent than total curcuminoids. Additionally, Zeng et al. looked at how piperine pre-administration affected the bioavailability of oral curcumin. [20]

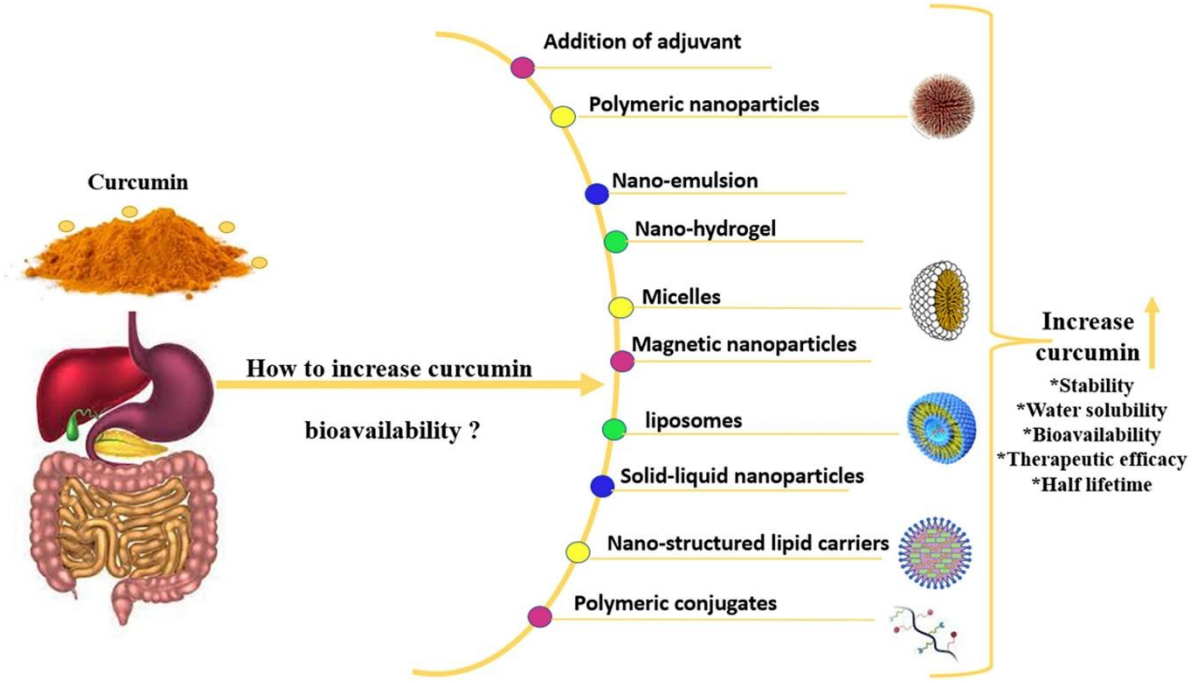

Figure 10*: *Bioavailability of Curcumin

CONCLUSION

Ancient pharmacy used curcumin for many years, and it was applied as a spice and food coloring in addition to a variety of medical procedures. Science has progressed over time, showing the numerous health advantages of curcumin for humans. Even now, chefs regularly utilize the

"golden spice" in their dishes. Nevertheless, the food and health sectors can now use curcumin for a variety of purposes thanks to technical advancements. Curcumin may be useful in the prevention and treatment of numerous diseases, including as heart attacks, diabetes mellitus, obesity, allergies, asthma, inflammatory disorders, and neurodegenerative diseases, according to the findings of preclinical and clinical investigations carried out in vitro and in vivo, respectively. conditions such as Huntington's disease, multiple sclerosis, Parkinson's disease, and Alzheimer's disease. Curcumin acts by influencing various molecular targets. Curcumin is considered as a moderately priced, safe natural remedy that can be used to treat and prevent many kinds of illnesses as compared to other pharmaceuticals. Clinical trial results indicate that nano-formulations are safe for circulation throughout the body and can improve curcumin absorption. However, before these nano-formulations be used in humans and for upcoming clinical trials, they need to be evaluated as therapeutic modalities. Moreover, curcumin nano-formulations can be used in conjunction with other medications to reduce the dosage of the main therapeutic component, hence improving therapeutic efficacy and minimizing systemic toxicity. Many curcumin nano-formulations, such as liposomes, there are currently dendrimers, micelles, nanogels, nanocrystals, and nanoparticles made of polymers. The above combinations are thought to be the cause of a few neurodegenerative illnesses, and they are the subject of numerous clinical and experimental investigations. [21]

REFERENCES

1. 1.Aggarwal B. B, Potential Therapeutic Effects of Curcumin, The International Journal of Biochemistry & Cell Biology, 2009: 41(1): 40-59.
2. 2.Rahul Kumar Verma, Introduction of Turmeric, International Journal of Conservation Science, 2018:2(1):26-27.
3. Adhimoolam Karthikeyan , Drug Metabolism and Transport, International Journal of Anti-inflammatory, 2020: 11(4): 497-498.
4. Amol V. Pore, Sanjay K. Bais, Ajit G. Chudhari, Priyanka S. Deokate, Priyanka B. Satpute, Advanced Herbal Drug Technology, International Journal of Pharmacy and Herbal Technology, 2023: 2(1): 6-16.
5. 5.Preeti Rathaur, Department of Biological Sciences, International Journal of Technology and Sciences, 2011: 3(1): 91-93.
6. Debjit Bhowmik, Pharmacological Properties of Curcumin, International Journal of Herbal Technology, 2009: 1(2): 86-108.
7. S K. Gupta, The Antibacterial and Antioxidant Properties of Turmeric, International Journal of Pharmacy and Pharmaceutical Science, 2015: 2(1): 51-55.
8. 8.Shirish B. Nagansurkar, Sanjay K. Bais, Rutuja Choragi, Herbal Plants Used in Acne Treatment, International Journal of Pharmacy and Herbal Technology, 2023: 1(3): 249-263.
9. Gupta S. C, Therapeutic Roles of Curcumin, American Association of Pharmaceutical Scientists Journal, 2013: 4(1): 195-198.
10. Kokate C. K, Pharmacognasy, 17th edition,Pune: 2001,pp. 106- 107.
11. Ranjeeta Gholve, A Spice with Multipurpose Medicative Features Turmeric, International Journal of Advanced Applied Research, 2022: 9(4): 2347-7075.
12. Chinemerem Henry Ugo, Effect of Processing Methods on The Nutritional Quality of Turmeric, Journal of Dietitians Association of Nigeria, 2022: 13(2): 123-126.

13. B Jyotirmayee, Pharmacological Activities of Curcuma longa, International Journal of Food Properties, 2022: 5(2):1377-1398.
14. Nida N. Mulla, Sanjay K. Bais, Kaveri S. Navale, Formulation and Evaluation of Herbal Drug, International Journal of Pharmaceutical and Herbal Technology, 2023: 8(1): 710-719.
15. Bharti A. C, Anticancer Potential of Curcumin, Preclinical and Clinical Studies, International Journal of Pharma and Biosciences, 2003: 23(9): 363-398.
16. Wolters Kluwer, The Phytochemistry, Pharmacology, And Pharmacokinetics of Curcumin Longae Rhizoma, Word Journal of Traditional Chinese Medicine, 2022: 8(4): 463-490.
17. Donatella Perrone, Biological and Therapeutic Activities and Anticancer Properties of Curcumin, International Journal of Pharmacy, 2015:10(5):1615-1623.
18. Selma Beganovic, Medical Properties Market Potential and Microbial Production of Golden Polyketide Curcumin for Food Biomedical and Cosmetic Applications, International Journal of Pharmaceutical and Herbal Technology, 2024:8(1):120-122.
19. Manish K. Pant, Curcumin A Wounder Therapeutic Drug, Word Journal of Pharmacy and Pharmaceutical Science, 2014: 3(6):374-396.
20. Same A. Korma, Impacts of Turmeric And its Principal Bioactive Curcumin on Human Health, International Journal of Biochemistry, 2022:9(2):466-468.
21. Preeti Kumar, Medicinal Properties of Turmeric, International Journal of Pharmaceutical Technology and Sciences, 2018: 6(4):1354-1357.