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MULTIFACETED APPLICATION OF CURCUMIN IN TRADITIONAL HEALTHCARE SYSTEM

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ABSTRACT: Curcumin, a substance produced from the root of the plant *Curcuma longa*, has been used for thousands of years in Ayurveda and traditional Chinese medicine to treat a variety of inflammatory disorders. Curcumin, the turmeric key ingredient responsible for this function, was discovered over two centuries ago. Curcumin exerts its effects *via* altering a number of crucial molecular targets, including transcription factors, enzymes, cell cycle proteins and cytokines according to modern science. Curcumin is currently used to treat a variety of disorders, including psoriasis, osteoporosis, Alzheimer's disease, diabetes, Crohn's disease, arthritis, and cancer. The history of curcumin in India as well as its traditional uses have been covered in this review. An overview of the possible health advantages of curcumin is also included in this paper. Further research on curcumin is required in order to examine additional areas and its real-world therapeutic uses for people.

INTRODUCTION: The active components of herbal remedies can be extracted from plants or other sources. A plant's seeds, berries, roots, leaves, fruits, bark, flowers, or even the entire plant can be utilised to make a herbal remedy. People used unprocessed plant material for many purposes in the past. Medical care is required to prevent sickness and maintain health. In India, traditional healthcare is provided using Indian herbal remedies or Ayurvedic drugs. A vast selection of medicines derived from herbs and plants has been used by Ayurvedic doctors for decades [1]. Ayurvedic medicine continues to be the major form of healthcare for 70% of Indians at the moment. With more than 126,000 species, India accounts for over 8% of global biodiversity.

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There are more than 400 families of flowering plants in the globe, and at least 315 of them are found in Indian subcontinent. Currently, Chinese, Indian, Arabic, and Western herbs are used to make herbal medicines and the things that go along with them on the worldwide market. Curcumin is the active entity derived from the *Curcuma longa* also known as turmeric. Turmeric is at the heart of Indian culture. It is a part of curries. Additionally, it is used in numerous Indian religious rituals. It is a part of several conventional medications. Turmeric is used as a medicinal herb in the majority of Asian countries due to its anti-inflammatory properties [2]. In addition, turmeric possesses anti-bacterial [3, 4], antioxidant, and anti-cancer properties [5, 6].

In south and southeast tropical Asia, the perennial herb turmeric (*Curcuma longa*), a member of the ginger family, is widely farmed. The most beneficial portion of the plant for both culinary and medicinal uses is the rhizome, commonly known as the "root" of this particular plant. Curcumin, which accounts about 2-5% of turmeric, is the spice's most potent ingredient.

The curcuminoids, which Vogel originally isolated in 1842, give turmeric its distinctive yellow colour. An orange-yellow crystalline powder known as curcumin is essentially water insoluble. In 1910, Lampe and Milobedeska provided the first description of the curcumin ($C_{21}H_{20}O_6$) chemical structure and established that it is diferuloylmethane [7]. Turmeric powder has recently been used in traditional Indian medicine to treat biliary diseases, anorexia, coryza, cough, diabetic wounds, hepatic disorders, rheumatism, and sinusitis. *C. longa* is used in China to treat disorders that cause stomach aches. The primary component of this plant, turmeric's colouring ingredient, is what gives it its anti-inflammatory properties [8].

FIG. 1: CURCUMIN

FIG. 2: CURCUMA LONGA ROOT

Botanical Information and Chemical Composition of Turmeric: Zingiberaceae, the ginger family, includes the flowering plant turmeric (*Curcuma longa*). It's a enduring herbaceous plant with rhizomes. It has a maximum height of one metre. The leaves are placed in two rows and alternated in their placement. They're composed of a leaf blade, a petiole, and a leaf cover. The covers of the leaves develop into a fake stem. Generally, the leaf blades are 76 to 115 cm in length.

They're oblong to elliptical in form, narrowing at the tip, and range in range from 38 to 45 cm (15 to 18 in). The blooms are zygomorphic and bisexual. There are three sections when the fruit capsule is opened. Nearly 20 species of the *Curcuma L.* genus' roughly 110 species have passed phytochemical exploration [9]. The species of Curcuma that has been chemically studied the most is *Curcuma longa*. There are now at least 235 recognised chemicals, substantially phenolic and terpenoids, similar as monoterpenes, sesquiterpenes, diterpenes, triterpenoids, alkaloids, and sterols. Diarylheptanoids, which are also known as curcuminoids, are one kind of diarylpentanoids [10].

Turmeric was described as *C. longa* by Linnaeus and its taxonomic position is as follows:

Class: Liliopsida
Subclass: Commelinids
Order: Zingiberales
Family: Zingiberaceae
Genus: Curcuma
Species: *Curcuma longa*

The wild turmeric is called *C. aromatica* and the domestic species is called *C. longa*.

The Chemical Make- up of Turmeric: Protein makes up 6.3% of turmeric's composition, along with fat (5.1%), minerals (3.5%), carbs (69.4%), and humidity (13.1%). A-phellandrene (1%), sabinene (0.6%), cineol (1%), borneol (0.5%), zingiberene (25%) and sesquiterpines (53%) [11] are each present in the essential oil (5.8%) produced by brume distillation of rhizomes.

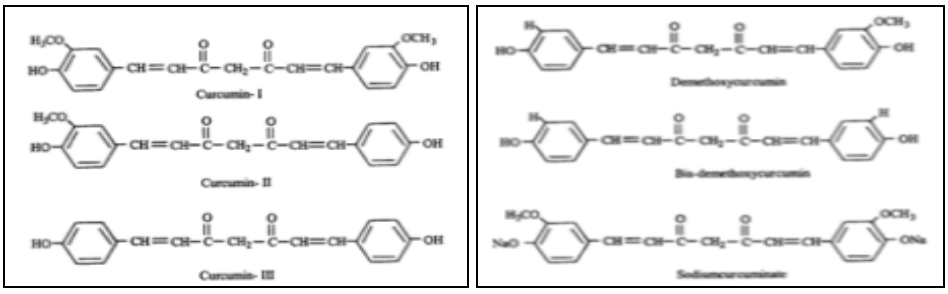

FIG. 3: STRUCTURE OF NATURAL CURCUMINOIDS

The yellow tone is caused by curcumin (diferuloylmethane), which is made up of curcumin I (94), curcumin II (6) [12] and curcumin III (0.3). Curcumin demethoxy and bisdemethoxy derivations have also been shown to live as shown in **Fig. 3** [13, 14]. Curcumin was firstly insulated in 1815, and Roughley and Whiting linked its chemical composition in 1973. It melts at between 176 and 177 °C, reacts with alkali to induce a sanguine- brown swab, and is answerable in ethanol, alkali, ketone, acetic acid, and chloroform [15].

Disease Targets of Curcumin: The use of curcumin for a wide range of inflammatory disorders, including sprains and swellings brought on by injury, wound healing, and gastrointestinal issues, is described in ancient Indian medical writings. Chinese texts on traditional medicine discuss the use of curcumin to treat illnesses that are connected to stomach discomfort. More than 1,500 references on curcumin's biologic impact may be found in Medline [16]. Curcumin's ability to reduce inflammation is likely the basis for the majority of its known uses. It has been demonstrated that curcumin is efficient in both acute and chronic forms of inflammation.

The results of several investigations indicate that curcumin is a strong antioxidant **Fig. 4.** In fact, studies have shown that curcumin has at least ten times the antioxidant activity of vitamin E[17] Haemoglobin oxidation is stopped by curcumin, which also reduces lipid peroxidation. Superoxide dismutase, catalase, and glutathione peroxidase are a few examples of antioxidant enzymes that may have a role in the antioxidant activity of curcumin. It has been demonstrated that curcumin functions as a Michael acceptor when interacting with glutathione and thioredoxin 1[18]. Curcumin's interaction with these substances causes the cells' intracellular GSH to decrease. Curcumin's ability to reduce lipid peroxidation may also reduce inflammation.

Curcumin's anticancer potential in several systems has recently been examined [19]. Invasion, angiogenesis, transformation, tumor start, and metastasis have all been demonstrated to be inhibited by curcumin. Curcumin inhibits mouse skin, stomach, colon, and liver carcinogenesis in vivo. Additionally, curcumin prevents mammary carcinogenesis. A wide range of tumor cells, including B-cell and T-cell leukaemia, colon cancer, epidermoid carcinoma, and several types of breast cancer cells, have all been demonstrated to be inhibited in their growth by curcumin.

Myocardial infarction and atherosclerosis have been successfully combated by curcumin. Curcumin prevents the growth of vascular smooth muscle cells (VSMCs) and peripheral blood mononuclear cells (PBMCs), which are indicators of atherosclerosis. Low-density lipoprotein (LDL) oxidation is stopped by curcumin, which also suppresses platelet aggregation and lowers the risk of myocardial infarction [20].

Curcumin has been proved to be beneficial against a variety of skin conditions, including dermatitis, psoriasis [21], scleroderma [22] and skin cancer. According to several findings, curcumin quickens the healing process. Curcumin also aids in muscle regeneration following injury [23] and inhibits the development of scarring.

In an alloxan-induced diabetic rat model, treatment of curcumin dramatically decreased the blood sugar, haemoglobin, and glycosylated haemoglobin levels. Diabetes-related excretion of albumin, urea, creatinine, and inorganic phosphorus was decreased in rats kept on a curcumin diet for 8 weeks. Additionally, in diabetic mice, dietary curcumin partially restored abnormalities in plasma albumin, urea, creatine, and inorganic phosphorus.

Additionally, curcumin has been reported to have anti-rheumatic and anti-arthritic properties, most likely via reducing the levels of COX2, tumor necrosis factor (TNF), and other inflammatory cytokines [21].

In Alzheimer's disease, curcumin can reduce amyloid buildup, oxidative damage, inflammation, and cognitive impairment [24].

Curcumin's preventive benefits against inflammatory bowel disease that was produced in a mouse model were recently studied by Ukil *et al* [25]. Curcumin pretreatment for 10 days in mice dramatically reduced the occurrence of diarrhoea and the alteration of the colonic architecture.

Cystic fibrosis transmembrane conductance regulator gene mutations are the primary cause of cystic fibrosis, the most prevalent deadly genetic illness in the white population. In a recent study, Egan *et al* [26]. showed that the cystic fibrosis abnormalities in DeltaF508 CF mice might be repaired by curcumin.

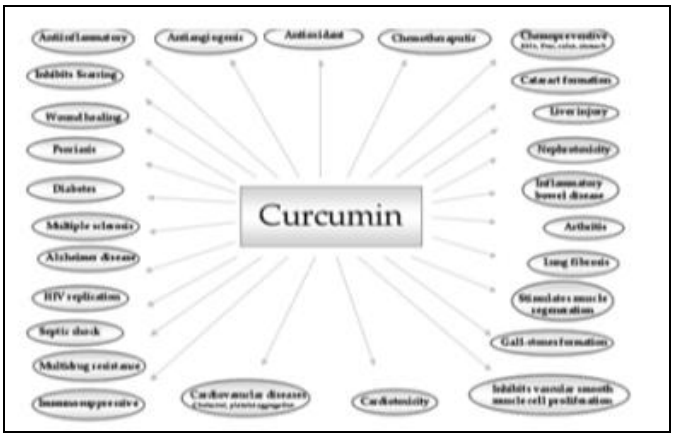

FIG. 4: DISEASE TARGETS OF CURCUMIN

Pharmacological Applications of Curcumin:
Effect on Gastrointestinal System:

Stomach: The stomach gets advantages from using turmeric powder. It causes rabbits to secrete more mucin, which may serve as a gastroprotectant against irritants [27]. However, there is debate concerning curcumin's antiulcer properties. Curcumin has been shown to have both antiulcer [28] and ulcerogenic [29, 30] properties, although more thorough research is still needed.

At a dosage of 50 mg/kg, curcumin has been demonstrated in guinea pigs to protect the stomach against the ulcerogenic effects of phenylbutazone [31, 32]. At a dosage of 20 mg/kg, it also offers protection against ulceration caused by 5-hydroxytryptamine. However, 0.5% curcumin was not effective in preventing ulcers brought on by histamine [33]. Indomethacin, ethanol, stress, and stomach ulceration may all be prevented by curcumin, according to recent research conducted in lab on rats. It can also prevent pylorus ligation, which causes acid secretion. Curcumin's ability to scavenge reactive oxygen species is how the antiulcer action is produced [34].

Intestine: The gut can benefit from curcumin in various ways as well. In an isolated guinea pig ileum, sodium curcuminate's antispasmodic effects were noted [35]. Rat tests conducted *in-vitro* and *in-vivo* both showed antiflatulent activity [36]. Additionally, curcumin increases intestinal lipase, sucrase, and maltase activity [37].

Liver: In cultured rat hepatocytes, curcumin and its analogues show antitoxin efficacy against carbon tetrachloride, D-galactosamine, peroxide, andionophore-induced toxicity [38, 39, 40]. Additionally, diethylnitrosamine and 2-acetylaminofluorine-induced altered hepatic foci formation are protected against by curcumin [41]. Both curcumin and *C. longa* essential oil were found to increase bile production in dogs [42, 43].

Effect on Cardiovascular System: Curcumin protects against myocardial infarction damage by reducing the intensity of pathogenic changes [44]. Curcumin enhances Ca2+ -transport and its escape from the sarcoplasmic reticulum of cardiac muscle, increasing the likelihood of pharmaceutical treatments to restore the cardiac muscle's deficient Ca2+ homeostasis [45]. In hypercholesteremic rats, curcumin significantly lowers cholesterol levels [46].

Anti-inflammatory Activity: In rats [47, 48, 49, 50] and mice [51], curcumin reduces oedema brought on by carrageenin. FHM and BHM, two of curcumin's natural equivalents, are also powerful anti-inflammatory substances [52]. The anti-inflammatory properties of *C. longa's* volatile oil 39, petroleum ether, alcohol, and water extracts are demonstrated [53]. Curcumin's antirheumatic action has also been proven in individuals who saw a noticeable reduction in symptoms after receiving curcumin [54]. Through preventing NFkB activation, curcumin has anti-inflammatory effects [55]. Activation of both AP-1 and NFkB [56] has been found to be suppressed by curcumin, which has also been demonstrated to lessen TNF-a-induced expression of the tissue factor gene in bovine aortic-endothelial cells. Curcumin's anti-inflammatory effects also result from a downregulation of cyclooxygenase-2 and inducible nitric oxide synthase caused by the reduction of NFkB activation.

Antioxidant Effect: Curcumin's antioxidant properties have been reported in 1975 [57]. It functions as an oxygen free radical scavenger [58, 59]. Haemoglobin may be shielded against oxidation by it [60]. Curcumin has been shown to greatly reduce the production of reactive oxygen species (ROS)

in-vitro, including superoxide anions, H_2O_2, and nitrite radicals, which are key players in inflammation [61]. Additionally, curcumin reduces ROS production *in-vivo* [62]. Demethoxycurcumin and bis-demethoxycurcumin, two of its derivatives, also show antioxidant properties [63]. Kelly *et al.* [64] reported that curcumin inhibits inactivation of gastric peroxidase, as well as direct scavenging of H_2O_2 and OH, to reduce oxidative damage during indomethacin-induced gastric lesion. Masuda *et al.* [65] conducted additional research on the antioxidant mechanism of curcumin using linoleate as an oxidizable polyunsaturated lipid and proposed that the mechanism involves an intramolecular Diels-Alder reaction after an oxidative coupling reaction at the curcumin's 3 position with the lipid.

Anticoagulant Activity: *In-vitro* and *in-vivo* platelet aggregation produced by collagen and adrenaline is inhibited by curcumin, demonstrating anticoagulant action in the rat thoracic aorta [66].

Antidiabetic Effect: At relatively low dosages, curcumin inhibits the production of cataracts brought on by galactose [67]. Both turmeric and curcumin lower blood sugar levels in rat [68] models of diabetes produced by alloxan. Additionally, advanced glycation end product-induced consequences in diabetes mellitus are reduced by curcumin [69].

Antibacterial Activity: The growth of various bacteria, including Streptococcus, Staphylococcus, Lactobacillus, and others, is inhibited by both curcumin and the oil fraction [70]. Turmeric rhizomes' aqueous extract exhibits antibacterial properties [71]. *In-vitro*, curcumin also inhibits the development of Helicobacter pylori CagA+ strains [72].

Antifungal Activity: Oil of *C. longa* and its extracts in ether and chloroform exhibit antifungal properties [73, 74, 75]. Additionally, crude ethanol extract has antifungal properties [76]. *Aspergillus flavus*, *Aspergillus parasiticus*, *Fusarium moniliforme*, and *Penicillium digitatum* are also susceptible to the effects of turmeric oil [77].

Antifibrotic Effect: In rats, bleomycin-induced lung fibrosis is suppressed by curcumin [78]. Taking curcumin orally at a dosage of 300 mg/kg prevents the bleomycin-induced rise in inflammatory biomarkers and total cell counts. Additionally, it reduces TNF-a, superoxide, and nitric oxide generation by alveolar macrophages that is produced by bleomycin. As a result, curcumin has powerful anti-inflammatory and antifibrotic properties.

Curcumin in Ayurveda: Curcumin use in Indian culture may be traced back to Vedic (Hindu scriptural era; term Veda refers to extremely old Indian Hindu scripture) times. In the TaittiriyaBrahmana and Atharva Veda, skin patches are coloured with turmeric. Additionally, there are mentions of consuming turmeric powder mixed with honey to improve memory and ghee (melted butter) to treat snakebites. Turmeric-infused rice is applied to the body and consumed internally by individuals with heart conditions and jaundice. The therapeutic benefits of turmeric have been described in great detail in the earliest manuscripts of Ayurveda, which date back many centuries before the Common period (Christian period).

Varieties of Turmeric Used in Ayurveda: There is only one species of turmeric used in Ayurveda, and it is without a doubt *C. longa*. However, in the past, people could tell the difference between the cultivated and wild forms of turmeric (Vanaharidra). In addition, a number of connected and unconnected species of medicinal plants have been recorded as variations in ancient writings. Due to its common usage in conjunction with turmeric and the fact that it also produces a yellow colour similar to that of turmeric, the plant *Berberisa ristata* is also known as woody turmeric or DaruHaridra (Haridra in Sanskrit). When combined with astringents and aromatics, a different kind of turmeric (*C. aromatica*) known as wild turmeric, AranyaHaridra, or KasturiManjal can treat bruises, sprains, hiccoughs, bronchitis, cough, leukoderma, and skin eruptions. Pharmacological activites of curcumin can be seen in **Table 1.**

TABLE 1: THE MAIN AYURVEDIC USE FOR TURMERIC (SINGLY OR IN COMBINATION)

Main drug	Combination drug	Usage	Purpose	References
turmeric	Mustard paste	Leech therapy	removing the leech and cleaning the wound	Sharma (1987)[79]

turmeric	Neem leaves	Ringworm, scabies chicken pox	antifungal and wormicidal skin treatment	Ibid. p.36,404, 433, 434
turmeric	Gooseberry juice	Antidiabetic	preventing microvascular deterioration	-
turmeric	Jaggery	Flush the calculus	Remove a urinary stone	Vaidya (2002)[80]
turmeric	Cow's urine	Antitoxic	avoidance of microvascular degeneration	Ibid. p.36,404, 433, 434
turmeric	Euphorbia species	Alkalifying effect	prevents haemorrhoids from bleeding	Trikamji (1980)[81]
turmeric	Oil	Inhalation	Nasal decongestant	-
turmeric	Buttermilk	Diet	antibacterial and digestive antidiarrheal	Trikamji (1980)[81]

Use of Curcumin (Turmeric) in Ayurveda: In Ayurvedic formulations, curcumin (turmeric) can be used alone or in combination, although as shown in **Table 2,** more often than not, it is combined with other herbs and medications.

TABLE 2: REPUTABLE AYURVEDIC MEDICINES THAT CONTAIN TURMERIC AS A KEY COMPONENT OR A SUPPORTING ELEMENT INCLUDE SOME IMPORTANT EXAMPLES

Type of medication	Name of formulation (medicine)	Medical assertions	References
Churnam	HaridraKhandam	Antiallergy and urticaria-relieving	Vaidya (2002)[80]
Churnam	RajanyadiChurnam	Many types of paediatric illnesses, especially those involving the duodenum, might profit from this digestive and appetiser.	Sastri (2002, p. 784)[81]
Kashayam	NishaKatakadiKashayam	Diabetes	Sharma (1987)[79]
Lehyam	Brahma Rasayanam	Rasayanam, which lengthens life	Trikamji (1980)[81]
Ghritam	Mahapancagavyaghritam	Constant usage is advised for illnesses like epilepsy and psychotic ones.	Sastri (1980)[82]
Ghritam	Kalyanakaghritam	For issues like epilepsy and psychotic ones, regular use is suggested.	Sastri (1980)[82]
Thailam	LakshadiThailam	prevents colds and upper respiratory illnesses in children, provides nutrition	joshi (1939, p. 505)[83]
Thailam	JathyadiThailam	cleans and supports healing	Vaidya (2002)[80]

The Multifaceted Uses of Curcumin (Turmeric) in Ayurveda: Turmeric has several therapeutic benefits, as shown by an examination of traditional and antiquated Ayurvedic literature. It enhances the complexion and skin tone. It functions as an antiseptic and an antibacterial agent, as well as healing wounds. It helps in the treatment of skin lesions brought on by ringworm infection and erysepalis as well as chronic wounds.

Turmeric is a fantastic liver tonic and carminative. It facilitates digestion and works as a powerful remedy for poisoning, whether it is internal poisoning from eaten food toxins or external poisoning from snake and scorpion bites. It is a component of a formula used to clean breast milk (Yadavji 1980, p. 168) and has been shown to have immunomodulatory effects (Trikamji 1992, p. 378) [84]. Turmeric is a key component of Ayurvedic remedies that are used to treat both benign and malignant tumours (Trikamji 1980). Additionally, turmeric has been shown to control uterine activity and lessen menstruation discomfort. Turmeric is used to treat respiratory diseases together with other herbs. It has been discovered that a mixture of oil, either coconut or sesame, and powders of turmeric, black pepper, raisins, jaggery, galangal root, long pepper, and Kaemferiagalanga will improve respiratory issues (Yadavji 1980, p. 331).

Jaundice can be treated with a straightforward mixture of turmeric, *Terminalia chebula*, *Terminalia belerica*, *Emblica officinalis*, *Azadira chtaindica* (the well-known neem), Sidacordifolia, and licorice root, as well as milk and ghee (melted butter) made from buffalo milk (Yadavji 1980, p. 276). According to legend, using turmeric, woody turmeric, and red ochre topically can counteract the harmful effects that animals' nails might cause (Trikamji 1992, p. 378).

Due to the derangement of Kapha in humans, a drink consisting of turmeric and sugar is advised in times of thirst since it is thought to be helpful (Yadavji 1980, p. 276).

The potential of turmeric to detoxify negative effects from metals, such as tin and iron, and minerals, such as mica, present in allopathic medication, is one of the spice's most significant uses (Satpute 2003) [85]. It serves as a key component in the creation of medicated enemas as well (Trikamji, 1980).

CONCLUSION: Curcumin has long been valued in India as a tasty, eye-catching spice as well as an Ayurvedic remedy to stimulate the appetite, function as a carminative, and cure dyspepsia, gallstones, and other biliary issues. It is used as an ointment, paste, or poultice for scabies, boils, bruises, insect bites, and other skin lesions. It is a traditional treatment in India, China, and other Southeast Asian nations to cure asthma and colds. Oral administration of curcumin is used to treat a wide range of various issues, such as menstrual irregularities, discomfort, epilepsy, respiratory tract infections, bleeding, diarrhoea, jaundice, and rheumatic illnesses. In more recent years, it has developed a reputation as an anti-inflammatory drug, a therapy for hypercholesterolemia, an antioxidant, and a cancer preventive. It is also said to stop cardiovascular and other degenerative processes of ageing. Modern science has now provided a scientific basis to the numerous reports of the medicinal effects of these most inexpensive, yet pharmacologically safe, polyphenols. Even though the majority of NSAIDS have been discontinued or are still on the market with black box warnings, curcumin is one that is not known to have any negative side effects, even at dosages as high as 8 g per day. Therefore, going back to our "roots" to investigate the *Curcuma longa* plant's "roots" as a potential source for more effective therapies would undoubtedly be fruitful.

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