

The Pharmacological Effects of *Curcuma Longa* Linn in Wound Healing and Relieving Inflammation

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Abstract: *Curcuma Longa* is the scientific name of turmeric, a member of the Zingiberaceae family of plants. It has been used in Ayurvedic medicine in different countries since long ago. But now, it is more popularly known for its wound-healing and inflammation-relieving properties. Curcumin is the biologically active ingredient responsible for these actions of *Curcuma Longa*. It acts at different stages of wound healing and makes it heal more quickly. It prevents inflammation and helps the immune system of the body. It also exhibits more pharmacological properties like anti-cancerous, anti-microbial, anti-diabetic, etc. This review will explain how curcumin heals wounds and acts as an antioxidant and anti-inflammatory. Moreover, this will also shed light on the latest formulations of curcumin, treating wounds and inflammation. Topical formulations are often used for immediate response and effect because they are very strong and provide relief quickly.

Key Words: Anti-diabetic, Antioxidant, Anti-microbial, Anti-inflammatory, Curcumin

Introduction

The history of *Curcuma* is more than 400 years old when it was mostly used in different areas of the India-subcontinent as a famous spice and flavoring agent. *It is an amorphous shape herb, with outgrowth. It was yellow from the inside as shown in Figure 1.* After 200 years Vogel and Pelletier did a lot of work on it and they published what they found during their research. In their publication, they said that they had isolated a powder that seemed to be yellow-colored, and it was extracted from the rhizome of the turmeric plant. This yellow matter was properly named in the 18th

century Curcumin. In India, it was named Haldi as its local name. *Curcuma longa* is an ancient medical plant also known as Turmeric in English. It has been used for more than 1000 years all over the world for various medical issues such as illness, organ disorders, internal infections, and wound injuries (Ahsan et al., 2020; Bagad, Joseph, Bhaskaran, & Agarwal, 2013). It is also used after medical procedures for the healing of wounds and preventing the chance of infections as a remedy in traditional Indian and folk Tales.

This herb became the most popular folk medicine of the 19th century, being very effective

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in treating injuries, wounds, sprains, inflammations, swellings, and other medical issues. It became popular in India, China, the south, and the Southeast due to the properties it contributes being antiseptic, antioxidant, anti-inflammatory, and anti-microbial (Omosa, Midiwo, & Kuete, 2017). The turmeric plant was used by Indians as a medicine in the past which they considered as

ayurvedic tea and they used to make it by boiling rhizome of turmeric in the water or sometimes they added it to their foods directly. These rhizomes were then gathered and grounded into a smooth refined powdery structure, this haldi was used for coloring food, dyeing clothes, and flavoring food.



Figure 1: *Curcuma Longa* Linn Physical Appearance.

It is regarded as traditional Indian medicine with anti-aging and wound-healing abilities. The powdered turmeric obtained from the rhizome was dissolved in milk and then this solution was taken by the people to treat muscular pain and cramps. It was regarded as a magical solution for reducing pain, enhancing blood circulation, increasing immunity, and promoting general wound healing process (Abbas et al., 2019; Sandur et al., 2007). In the 19th century, Milobedzka researched *Curcuma longa* Linn and then in 1910,

he identified the organic structure for curcumin, later it was synthesized by Lampe in 1913. *Curcuma* Herb is an organic compound that is bioactive in nature, also known as diferuloylmethane. Its chemical formula is $C_{12}H_{20}O_6$ and its structural formula is given by Figure 2. It has low molecular weight and is soluble in organic solvents but soluble in aqueous solvents. It contains a definite proportion of carbohydrates, proteins fats.

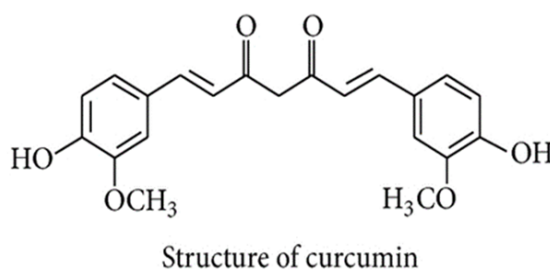


Figure 2: The Structural Formula of *Curcuma longa* Linn.

Curcuma longa Linn is the botanic name of the turmeric herb, which is a perennial plant belonging to the angiosperms plant division. It is rhizomatous and belongs to the family of ginger Zingiberaceae. It has highly branched rhizomes which are yellow or orange, with alternative leaves in both rows (Barchitta et al., 2019). It is cultivated in adverse environmental conditions such as high temperatures ranging from 20-40°C. It grows in well-drained soil within a shady sun with an annual rainfall of 1500mm. It is mostly cultivated in countries like India, China, Africa, and other tropical and sub-tropical regions where the climate is wet. Turmeric herb is used worldwide. For advantages, turmeric herb is used worldwide for various purposes in kitchens, cosmetic factories, homes, and hospitals traditional spice for flavoring food, and ginger tea for taste and digestive purposes. It is used in cosmetics for skin whitening and other skin-related considerations due to its antioxidant property, it is used in various cosmetic products (Omosa et al., 2017). It is beneficial in treating various wounds, infections, and inflammations due to its anti-inflammatory and anti-microbial qualities. It also increases blood circulation and improves the immunity system. Curcuminoids are biologically active constituents and belong to phenolic compounds composed of more than 100 individual curcuminoids which were isolated and identified from the genus *Curcuma*, approximately 50 of these compounds are present in *C. longa* (turmeric). Curcuminoids are chemically broken down in aqueous-organic solutions, particularly at alkaline pH, or in dilute solutions of curcuminoids.

Turmeric is an ancient herb that is employed for the treatment of rheumatoid arthritis, diabetic ulcers, gastrointestinal ulcers, anorexia, corneal infections, cough, and sinusitis (Fadus, Lau, Bikhchandani, & Lynch, 2017). It is very useful in increasing musculature, enhancing immunity, and promoting blood circulation. Curcumin *longa* Linn is used in chemotherapeutic treatments for curing diabetes and malaria for the past 60 years (Barchitta et al., 2019). Curcumin plays a vital role

in a variety of areas being used as a dyeing agent and therapeutic agent to minimize renal hypertrophy and matrix expansion. Additionally, it drastically lowers the levels of mature interleukin-1, cleaved caspase-1, and NLRP3 protein in the renal cortices of db/db mice as well as in HK-2 cells. It also inhibits the increased protein and mRNA expressions of collagen IV and fibronectin in the renal cortices.

Curcumin was used in chemotherapeutic dosage for safe and painless treatment of various types of cancers such as skin, oral, Breast, renal ovarian, and prostate cancer (Chusri et al., 2012). A synthesized form of curcumin is used to treat cancerous cells as it enhances bioavailability, due, due to its long half-life and cytotoxicity. It efficiently degrades tumor cells and prevents them to proliferate in other surrounding areas. Curcumin has anti-microbial properties, for a variety of bacterial and viral species. It was beneficial in increasing the spread of infection or illness by the spread of microorganisms. *Curcuma longa* Linn was used as a folk medicine because it helps in boosting the immune system by increasing the metabolism and regulating the optimal flow of blood between the heart and surrounding body parts (Kohli, Ali, Ansari, & Raheman, 2005). So, it is very much beneficial in treating HIV, as immunity is reduced in it. *Curcuma longa* Linn has antioxidant properties, due to which it is frequently used to treat endothelial dysfunctions that are caused by diabetes. It happens because the chemical constituents of curcumin reduce the production of superoxides and protein kinase C. It is used in preventing diabetes and treating diabetic-induced illnesses and other health issues. It is a neurodegenerative disorder of the brain which is chronic and progressive in nature. A sudden decline in cognitive and behavioral activities is the most common symptom of Alzheimer's. Curcumin acts as an anti-Alzheimer agent because it reduces the accumulation of amyloid β -peptide. Common respiratory disorders such as rhinitis, sinusitis (Figure 3), bronchitis, and sore throats are

effectively treated by the administration of fresh juices of rhizomes of the *Curcuma* plant. The special chemical constituents of curcumin also

possess anti-asthmatic characteristics (Krup, Prakash, & Harini, 2013).

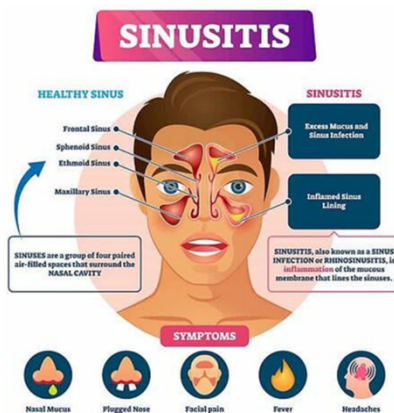


Figure 3: Internal Inflammation of Sinusitis, which is Treatable by Curcumin Cava.

Pharmacological Role of the Herb in Healing Wounds and Inflammation

Curcumin is a combination of three components including diferuloylmethane, desmethoxycurcumin, and bisdemethoxycurcumin. It contains a definite proportion of carbohydrates, proteins fats. It has various pharmacological effects including antioxidant, antibacterial, anti-inflammatory, protective, anti-tumor, and anti-viral activities. It has been proved that curcumin is a potential agent for the prevention and treatment of different cancers including gastrointestinal, breast, lung, melanoma, head, and neck, neurological, and sarcoma cancers. Curcumin is offered in a variety of forms, including tablets, ointments, and capsules. 15. The US Food and Drug Administration has approved curcumin aids, Generally Recognized as Safe" by the Food and Drug Administration (GRAS). A wound is a type of injury in which tissues of the body are cut, torn, or torn either due to any external or internal cause including; road accidents, sports injuries, stair falls, ulcers, infections, and many more. Whereas wound healing is a process of healing and repair of

injured tissues (Kulac et al., 2013). Various factors and agents play a crucial role in promoting the healing of wounds. Turmeric is an ancient plant frequently used for the treatment of wounds (Omosa et al., 2017). The polyphenolic constituents of *Curcuma longa* Linn proved beneficial in promoting healing by accelerating the metabolic activities in the victim. The application of Turmeric powder on the site of the wound degrades all surrounding microorganisms and enhances platelet formation in the area which in turn promotes phases of wound healing. Deep wound injuries cause sufficient protein loss which may have negative effects on immunity. Adequate intake of specific nutrients such as iron, zinc, and vitamins are necessary for the inflammatory process to begin and to promote the synthesis of collagen fibers in the injured area. Curcumin has anti-inflammatory and antioxidant characteristics (Mosovska, Petakova, Kalinak, & Mikulajova, 2016), which in turn diminishes the tumor necrosis factor-alpha (TNF-) and interleukin-1 (IL-1) expression, which may also help to balance reactive oxygen species (ROS) (Araújo & Leon, 2001). It initially produces inflammatory cells than as the healing phase of the wound healing is

started, these inflammatory cells are undergoing the process of apoptosis. This reduces the length of this phase, latterly accelerating the process of wound healing (Barchitta et al., 2019).

Recently, biomedical applications have evidently proved that curcumin plays an important role in wound healing. Curcumin is a natural polyphenolic antioxidant ingredient that has recently been extensively studied for its potential use as a wound-healing agent (Osawa, Sugiyama, Inayoshi, & Kawakishi, 1995). The primary goal of wound healing is since it upholds the integrity of tissues and homeostasis. It is proved that curcumin improves the wound area by up to 20% (Cheppudira et al., 2013). The anti-oxidant property of Curcumin is due to its ability to shift electrons instantly to form two methoxy phenol groups while giving two hydrogen atoms as well. This property is mainly due to the presence of the b-diketone and many p electrons that have a prominent electron transfer ability in its structure (Asakawa, 2012; Tanvir et al., 2017). Oxidants cause damage to the body in terms of aging and several other diseases. Curcumin not only attacks

the oxidants but also stops the production of ROS in the body. Curcumin inhibited the inflammatory response and accelerated wound healing by regulating the enzymatic response and release of specific chemicals which promotes the synthesis of collagen fibers. It basically decreases/suppresses the gene expression for inflammatory cytokines which are responsible for producing inflammation (Menon & Sudheer, 2007). Curcumin promotes healing in different manners either by accelerating the remodeling phase or reducing the inflammatory phase (Abdel-Lateef et al., 2016). In both cases process of re-epithelialization is increased, vascularization is improved and different cells are migrated at the wound site. These cells are fibroblasts and myofibroblasts, which are then phagocytosed/eaten up by the wound bed. So, we can say that it basically provides strength to our body and helps the immune system perform its function in defending the body against foreign attackers and recovering from the damage caused. Here are the stages of wound healing where curcumin plays its role in relieving inflammation as well (Table 1).

Table 1. Wound Healing Stages by Curcumin.

Stages of Wound Healing	Pharmacological Action of Curcumin
1. Inflammation	<ul style="list-style-type: none"> ▪ Play the role of antioxidant by attacking and neutralizing the reactive oxygen species/oxidants. ▪ Prevents the damage caused to the lipids and DNA by these oxidants and in this way, it leads to the healing of the wound in the tissues where an injury occurs. ▪ Increases inflammatory activities by acting on cytokines which play a crucial role in inflammation recovery.
2. Proliferation	<ul style="list-style-type: none"> ▪ Curcumin provides quick tissue recovery with the early formation of cells and collagen at the site of injury. ▪ This also initiates apoptosis earlier to remove the debris so wounded tissues may heal soon.
3. Remodeling	<ul style="list-style-type: none"> ▪ Initiates the formulation of interstitial fluid and other growth factors like TGF at the wound site so that they wound may contract and heal soon.

Inflammations were also treated by Curcuma in old times as it was traditionally used by some people. Inflammation is a painful physical condition in which there is redness and swelling in a specified area in response to any infection or

injury (Orkun, Sefa, Osman, & Murat, 2020). Curcumin is directly applied to the inflamed area, which results in reducing pain and swelling. Curcumin is beneficial medicine for treating muscular pain, ankle or wrist sprains, strains, and

ligamentous injuries besides inflammation only. Figure 4 shows the different stages of wound healing where the action of curcumin is evident

(Mohanty & Sahoo, 2017). Rheumatoid Arthritis is an inflammatory disease of joints, most commonly.

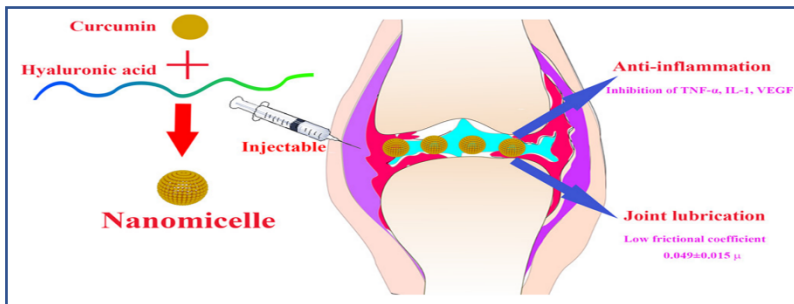


Figure 4: The Process of Wound Healing in the Wounded Cell.

Affecting the knee joints. In this inflammatory joint disease, there is hyperplasia of fibroblastic cells of the synovial membrane (Barchitta et al., 2019). Curcumin possesses anti-inflammatory properties which are useful in treating arthritis. Insertion of curcumin within the synovial area reduces the growth process and activates the

process of apoptosis to treat inflammation in the joint (Ramsewak, DeWitt, & Nair, 2000). Curcumin is also used to diminish the production of various chemicals which cause inflammation such as phospholipase, thromboxane, leukotrienes, nitric-oxide, prostaglandins, collagenase, and elastase.

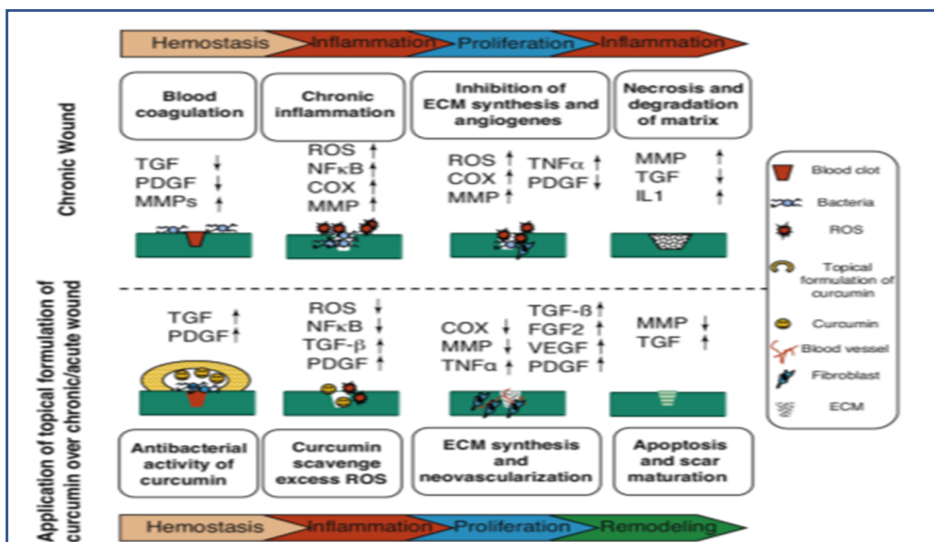


Figure 5: The Healing Process of Rheumatoid Arthritis by Injecting Curcumin.

In 2018, Ali Alsamyda and Nisrein Jaber elaborated the pharmacological aspects of curcumin. They have summarized their findings on the biological importance of curcumin with respect to pharmaceuticals (Alsamyda & Jaber,

2018). Curcumin is an herbaceous plant with clinical significance due to its chemical constituents and their affective roles being anti-inflammatory, antioxidant, anti-diabetic, wound healing, and anti-angiogenic. Curcumin is found to

be effective in treating deadly conditions such as cancer (Boroumand, Samarghandian, & Hashemy, 2018). This paper has focused on the biological activities of curcumin and its effectiveness in medical sciences. Aminul Islam and Leroy Rebello have worked with their colleagues on the nano-formulation of curcumin. In their research, they have introduced the derived compounds of *Curcuma* rhizome. The study was focused on developing a variety of nanotechnology delivery systems for the utilization of curcuminoids (Islam, Rebello, & Chepyala, 2019). The original natural compound of *Curcuma longa* Linn was found to be insoluble in water so due to its least absorption; it cannot be utilized to meet the needs in various fields for specific purposes. They found that due to the unavailability of the drug in the drug after administration, nano-formulation of Curcumin was not effective enough but as they enhanced the

bioavailability, the availability of formulation at the target site also increased and that's how it became more effective (Krup et al., 2013). To meet the needs and overcome the research gaps, Aminul and Leroy described various techniques by which drugs can be extracted from the *Curcuma longa* plant in their research. Apart from the nano-formulation, many topical formulations have been prepared and tested like films, emulsions, and gels/hydrogels. These formulations have been useful in the case of targeted drug delivery. These formulations are beneficial in this aspect because they provide spontaneous effects and an alternate route of administration in order to avoid any allergic reactions (Table 2). This review paper has thoroughly addressed the biological effects of the chemical constituents of curcumin in promoting human health.

Table 2. Some Topical Formulations Prepared to Treat Wound Healing and Inflammation (Mohanty & Sahoo, 2017; Yallapu, Nagesh, Jaggi, & Chauhan, 2015).

Type of Formulation	Route of Preparation	Composition
1. Film (collagen film)	Cross-linking	Collagen: bovine Achilles tendon & Curcumin.
2. Bandage	Cross-linking & Ions involving Interaction	Oleic Acid, Chitosan, Salt of alginic acid & Curcumin.
3. Hydrogel	Thin film (evaporation method)	Oxidized salt of alginic acid, Chitosan, Methoxy poly (ethylene glycol)-poly(ϵ -caprolactone) copolymer & Curcumin.
4. Emulsion	Emulsion techniques	Tween 80, Lipoid S100, Hydraulic acid & Curcumin.
5. Nanovesicles	Sonication technique	Lipoid S75, Polyethylene Glycol-400, Oramix & Curcumin.
6. Nanofibers	Electrospinning technique	Poly(ϵ -caprolactone) Fibers & Curcumin.
7. Nanocrystal (scaffolds containing curcumin-loaded microspheres)	Solvent evaporation technique	Collagen, Gelatin (bovine) & Curcumin.

Although *Curcumin longa* (turmeric) has been used for many different things since antiquity, it has become more of a medicinal medicine as researchers have learned about its pharmacological qualities. Although it has a wide range of therapeutic benefits, including anti-cancer, anti-diabetic, and anti-microbial qualities, its clear and

important function is in the healing of wounds and the reduction of inflammation (Noorafshan & Ashkani-Esfahani, 2013). When it was originally discovered that curcumin may help with inflammation and wound healing, it wasn't immediately evident how to utilize it or in what dosages. Eventually, a few researchers were able

to create some formulations, but these were useless because of their poor solubility qualities (Ammon & Wahl, [1991](#)). Researchers soon made it possible to use it for even additional disorders after finding that bioavailability augmentation might increase its effectiveness. It is now offered in a wide variety of topical formulations for inflammation and wound healing.

Curcumin was found to have the potential to influence different molecular pathways through a variety of mechanisms including the activation of apoptosis, the regulation of survival signals, and the prevention of reactive oxidant species (ROS). Curcumin was found to be effective for stress management, obesity-related health issues, the effects of aging, and the treatment of cardiovascular-related disorders (Ayman, Hassan, Mohamed, & Mohammed, [2019](#)). Curcuma Longa has been used in Ayurvedic medications for bone healing and injuries from the old times. It was used as a Folk medicine in some areas of India like U.P, Bihar and now in recent research, it has been found that it possesses anti-cancerous properties as well. Curcumin is the active ingredient of *Curcuma Longa* which is the cause of its potential pharmacological activities and due to its potent pharmacophores (Liju, Jeena, & Kuttan, [2011](#)).

Conclusion and Future Prospects

The two pharmacological effects of *Curcuma longa*—wound healing and inflammation relief—are primarily illustrated in this research. It removes the free radicals from the body and treats some other dreadful diseases. One compound that has a significant role in both wound healing and inflammation prevention is curcumin. Its pharmacophore performs these activities, allowing it to produce collagen and regenerate tissues and cells. Additionally, it serves as a scavenger to combat ROS (reactive oxygen species), and by doing so, it helps injuries heal more quickly and painlessly by inhibiting localized inflammation. So, we can say that its anti-inflammatory and antioxidant properties are helpful, and the new topical forms make it easier to use. Researchers were able to conduct extensive research and clinical trials on the formulation because bioavailability has been a significant barrier to its efficacy. Clinical trials are making formulations that can treat other life-threatening diseases like cancer and neurodegenerative disorders safely and effectively. Recent advances have made it possible to treat Alzheimer's disease with curcumin longa. But it can still make a big difference in medicine because turmeric has already been shown to be helpful in many ways. Moreover, it will soon be available in several other dosage forms without any bioavailability issues.

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