Curcumin- Nature’s Remedy for Oral Diseases

Chaya M David¹, Kanaparthi Alekhyā², Mahesh D R³, Soujanya LK⁴, Garima⁵, Raunaque Saba⁶

¹Professor and HOD, Department of Oral Medicine and Radiology, Dayananda Sagar College of Dental Sciences, Bangalore-560078
²Postgraduate Student, Department of Oral Medicine and Radiology, Dayananda Sagar College of Dental Sciences, Bangalore-560078,
³Reader, Department of Oral Medicine and Radiology, Dayananda Sagar College of Dental Sciences, Bangalore-560078
⁴Postgraduate Student, Department of Oral Medicine and Radiology, Dayananda Sagar College of Dental Sciences, Bangalore-560078
⁵Postgraduate Student, Department of Oral Medicine and Radiology, Dayananda Sagar College of Dental Sciences, Bangalore-560078
⁶Postgraduate Student, Department of Oral Medicine and Radiology, Dayananda Sagar College of Dental Sciences, Bangalore-560078

Abstract: Turmeric is a spice, used in India and other Asian countries for centuries because of its medicinal properties.¹ It is derived from the roots of the plant Curcuma longa, which is a member of the Zingiberacea family.²³ Curcumin, the principal Curcuminoids found in Turmeric, is generally considered as the most active constituent responsible for its therapeutic benefits. In addition to Curcumin, the turmeric is also composed of other Curcuminoids like demethoxycurcumin, bisdemethoxycurcumin and essential oils that have been responsible for the therapeutic effects.²³ Recent evidences suggested that Curcumin has multiple mechanisms of actions like anti-inflammatory, antioxidant, antimicrobial and anticancer activities. This, lead to the renewed scientific interest in this ancient spice to prevent and treat various oral diseases including oral cancer.¹ The aim of this article is to review the pharmacological actions and therapeutic benefits of Curcumin in the treatment of oral diseases.

Keywords: Curcumin, Curcuminoids, Oral diseases, anti inflammatory, antioxidant

1. Introduction

Nature has gifted mankind with various natural plant resources; many of these natural products derived from plants have played a pivotal role in the health care both in ancient and modern society. Though the mechanisms of action of traditional medicines are shrouded in mystery; man has relied upon them for their medicinal values and beneficial effects for the treatment of various ailments. Great Healers, in one form or another are sought out by us as a part of our daily diet. One such regularly used culinary spice in the house hold eaten throughout Asia as a food both in raw and cooked forms is Turmeric. Curcumin is derived from the rhizome (underground stem), and is an active component of plant Curcuma longa.¹

Ever since its historical discovery, Curcumin has assayed an extremely crucial role. It was used in ancient Indian medicine for the treatment of illnesses due to its antiseptic, antifungal, anti-inflammatory and antioxidant properties.¹² A need for a newer, safer, cheaper and effective therapy to enhance people’s health made a way for this natural medicinal spice with innumerable healing properties into modern medicine. This review is an attempt to provide a much deeper understanding of Curcumin and its therapeutic potentials for various oral diseases.

2. History of Curcumin

Curcumin is considered as one of the most beneficial compounds due to its medicinal properties. It is extracted from the turmeric plant (Curcuma longa); the history of which dates back to about 5,000 years as a principal healing agent in traditional system of medicine.¹² Sushruta’s Ayurvedic Compendium, dating back to 250 BC, recommends use of turmeric to relieve the effects of poisoned food.³

The advancements in the field of medicine lead to the discovery of Curcumin, two centuries ago when Vogel and Pelletier reported the isolation of “yellow coloring material” from the rhizomes of Curcuma longa and named it as Curcumin in 1842.¹²⁶ In the decades that followed, several chemists reported possible structures of Curcumin. Milobedzka and Lampe in 1910 identified the chemical structure of Curcumin as diferuloylmethane.¹³ Further work by the same group in 1913 resulted in the synthesis of the compound.¹¹ Subsequently, Srinivasan separated and quantified the components of Curcumin by chromatography.¹³ From there on, more than 100 components, including the volatile oils that have the therapeutic properties have been isolated from turmeric and the research still continues.¹²

3. Composition

Curcumin occurs naturally in the rhizome of Curcuma longa, which is grown commercially and sold as turmeric.¹ Curcumin is the phytochemical that gives turmeric its yellow color and is now recognized as being responsible for most of the therapeutic effects. Curcumin isolated from turmeric plant, once believed to be a single component later found to have three closely related species.¹² The Curcuminoids constitute approximately 5% of most turmeric preparations are a mixture of three principal compounds: Curcumin (Curcumin I), demethoxycurcumin (Curcumin II), and bisdemethoxycurcumin (Curcumin III).¹³ All the three Curcuminoids are equipotent in exhibiting the therapeutic actions. Hence, most of the studies refer Curcumin as a whole component rather than individual components.
components. The turmeric also contains several volatile oils like germacone; termerone; β-termerones; β-sisabolene; α-curcumene; zingiberene bisacurone; alkaloids and sterols. These Curcuminoids and essential oils have been reported to be the main components responsible for eliciting the medicinal properties.\(^1\)

### 4. Mechanisms of Action of Curcumin

Over the decades several studies have identified various molecular mechanisms of action of Curcumin. It modulates numerous molecular targets by altering their gene expression, signaling pathways or through direct interaction.

#### Anti-inflammatory action:

Curcumin acts via single or combination of any of the mechanism involving inhibition of arachidonic acid metabolism, inhibition of cyclooxygenase (COX), inhibition of the prostaglandin synthesis, inhibition of lipooxygenase (LOX), inhibition of cytokines (IL, TNF) release of steroid hormones from the adrenals and stabilization of lysosomal membrane.\(^3\,\,6\)

A study conducted by Srivastava et al demonstrated that Curcumin inhibited the incorporation of arachidonic acid into platelet phospholipids and inhibited the deacylation of phospholipids. Thus inhibits synthesis of prostaglandins through inhibition of COX enzyme.\(^6\) Ramsewak et al demonstrated that Curcumin I–III were active against COX-I enzyme with 125 µg/ml and showed 32%, 38.5% and 39.2% inhibition of the enzyme, respectively. They suggested that Curcumin reduces pro-inflammatory cytokine synthesis via inhibition of LOX enzyme.\(^6\)

Recent studies have demonstrated that nuclear factor κB (NF-κB) was involved in regulation of COX-2 & iNOS expression. Sahu suggested that Curcumin down-regulated the levels of COX-2 and iNOS through suppression of NF-κB.\(^6\)

Stabilization of lysosomal enzymes by Curcumin is also one of the mode in which Curcumin shows its anti-inflammatory action. A study conducted by Srivastava R et al comparing Curcumin and ibuprofen showed Serum phosphatase activity increased from 7.26 to 15.4 units due to inflammation. They concluded that Curcumin prevented the increase by 50% and hence, showed lysosomal membrane stabilization effect.\(^6\)

#### Antioxidative effect

Curcumin is a unique antioxidant, the presence of the hydroxyl groups in the chemical structure of all the Curcuminoids ensures antioxidant activity. Curcumin, shows free radicals scavenging action and also inhibits the formation of reactive oxygen species (ROS) like hydroxyl radicals, superoxide radicals, peroxyl radicals and peroxynitrite.\(^5\)

Curcumin contains two electrophilic unsaturated carbonyl groups, which can react with nucleophiles such as glutathione. Curcumin and its compounds have been recently demonstrated to induce the activities of detox system.\(^1\) Curcumin was found to generate hydroxyl radicals through the Fenton reaction by reducing Fe\(^3+\) to Fe\(^2+\). Reddy ACP et al conducted a study on the effect of Curcumin and eugenol on the generation of reactive oxygen species in model systems were investigated. Both Curcumin and eugenol inhibited superoxide anion generation in xanthine-oxidase system to an extent of 40% and 50% respectively. The OH-radical formation was inhibited to an extent of 66% and 46%, respectively, by Curcumin and eugenol. They concluded that Curcumin prevented the oxidation of Fe\(^3+\) in Fentons reaction which generates OH radicals.\(^7\)

Curcumin through ROS-dependent mechanism perturbs multiple cell signaling molecules is known to exert its anticancer effect either by scavenging or by generating reactive oxygen species (ROS). They also reported a better correlation between anti-inflammatory activity and superoxide scavenging property.\(^7\) Balasubramanyam et al demonstrated that Curcumin abolished ROS generation in cells from control and diabetic subjects. The pattern of these ROS inhibitory effect by Curcumin proves it to be a potent antioxidant.\(^7\)

Curcumin is capable of scavenging oxygen free radicals, such as superoxide anions and hydroxyl radicals, which are the initiators of lipid peroxidation. The lipid peroxidation has a main role in the inflammation, in heart diseases, and in cancer.\(^7\) Jayaprakash et al demonstrated the protective effect of Curcumin against the cytoxic effects of ethanol by measuring lipid peroxidation in terms of thiobarbituric acid reactive substances of malondialdehyde formed/100gm tissue. They found that the amount of lipid peroxidation was increased by ethanol only by two folds compared to control, but with liver cells pretreated with Curcumin the level of lipid peroxidation lowered to reach control level.\(^6\) Priyadarshini et al evaluated the antioxidant mechanism of Curcumin and dimethoxy Curcumin by radiation-induced lipid peroxidation in rat liver microsomes. They concluded that at equal concentration, the efficiency to inhibit lipid peroxidation is changed from 82% with Curcumin to 24% with dimethoxy Curcumin.\(^6\)

#### 5. Antimicrobial Action

Studies have reported that Curcumin show a broad-spectrum of antimicrobial activity that includes antibacterial, antiviral and antifungal activities.\(^8\)

##### a. Anti bacterial

One of the probable antibacterial mechanisms of actions is by inhibition of the cell dynamics. Curcumin via inhibition of assembly dynamics of FtsZ in the Z-ring can possibly suppress the bacterial cell proliferation. Kaur S et al conducted a study to evaluate the inhibitory effect against FtsZ on E. coli and B. subtilis. They concluded that Curcumin could suppress the FtsZ assembly leading to disruption of both the prokaryotic cell division causing the bacterial cell death.\(^8\)

A study conducted by Niamsa N et al to assess the antibacterial activity of C. longa rhizome extract and they demonstrated that Curcumin is a potent bacterial agent with minimum inhibitory concentration value of 4 to 16 g/L and minimum bactericidal concentration value of 16 to 32 g/L.
against S. epidermis ATCC 12228, Staph aureus ATCC 25923, Klebsiella pneumoniae ATCC 10031 and E. coli ATCC 25922.

b. Anti viral

It has been demonstrated that Curcumin as a plant derivative has a wide range of antiviral activity against different viruses. Therapeutic target for antiviral activity of Curcumin is by reduction of viral RNA expression, protein synthesis, and virus protease. In addition, it was found to have a protective effect on cells against virus-induced apoptosis and cytopathic activity.

The clinical trial conducted by Ungphaiboon S on HIV patients using clear liquid soap containing 0.5% w/v ethanol extract of C. longa rhizome demonstrated reduced the wound infections and 100% decrease in itching symptom and it also affected the abscess to convert to dryness scabs (78.6%).

Chen DY et al conducted a study on the anti-influenza activity of Curcumin against influenza viruses PR8, H1N1, and H6N1. The results showed more than 90% reduction in virus yield in cell culture using 30 μM of Curcumin against influenza viruses. Divya CS et al conducted a study to evaluate Antitumor action of Curcumin in human papillomavirus. They concluded that Curcumin showed inhibitory activity against the expression of E6 and E7 genes of HPV-16 and HPV-18 that are highly oncogenic human papilloma viruses.

c. Antifungal activity

Traditionally turmeric was used in food products, as it prevented fungal related spoilage of food. Extensive research on has been carried out proving Curcumin, a derivative of turmeric as a natural antifungal agent.

The mechanism demonstrating antifungal effect of curcumin was found to be down regulation of desaturase leading to significant reduction in ergosterol of fungal cell. Reduction in ergosterol results in accumulations of biosynthetic precursors of ergosterol causing cell death via generation of ROS and reduction in proteinase secretion are other possible critical factors for antifungal activity of Curcumin.

Ungphaiboon S et al conducted a study using the methanol extract of turmeric and demonstrated antifungal activity against Cryptococcus neoformans and Candida albicans with MIC values of 128 and 256 μg/mL, respectively.

A study conducted by Neelofar K et al to evaluate efficacy of Curcumin against 14 strains of Candida isolates proved that Curcumin is a potent fungicide compound against Candida species with MIC values range from 250 to 2000 μg/mL.

A study by Khan N et al demonstrated anti-Candida activity of Curcumin against 38 different strains of Candida including some fluconazole resistant strains and clinical isolates of C. albicans, C. glabrata, C. krusei, C. tropicalis, and C. guilliermondii. The MIC₉₀ values for sensitive and resistant strains were 250–650 and 250–500 μg/mL, respectively. Further more they suggested that possible mechanism for cell death of Candida species was through intracellular acidification via inhibition of H⁺ extrusion.

Tsao SM et al studied antifungal activity of Curcumin on 200 clinical isolates of Candida species. They demonstrated fungicidal activity for Curcumin with MIC value of 32–128 μg/mL. Combination of Curcumin with amphotericin exhibited synergistic activity, suggesting that combination treatment of Curcumin with existing fungicidal agents provided significant effect against systemic fungal infections.

d. Anti carcinogenic

Curcumin as an anticarcinogenic is one of the most common agent under extensive medical research. Various in vitro and in vivo studies have reported that there are several pathways and molecular targets that play an active role in the stages those relating to invasion, growth, metastasis, inflammation, angiogenesis and survival of cancer cells.

A wide variety of effects of Curcumin are mediated by its capability to act as a free radical scavenger, to alter gene expression of various stress protein and genes involved in angiogenesis, and to inhibit activity of many important transcription factors, an anti-inflammatory, as there is suggestive evidence that inflammation may have an active role in the three phases of carcinogenesis by its ability to selectively modify various cell signalling molecules.

Curcumin regulates the expression of inflammatory cytokines (e.g Tumor Necrosis Factor-alpha (TNF-α) and Interleukins (IL-1), growth factors (e.g. VEGF, EGF), growth factor receptors (e.g., EGFR, HER-2, AR), enzymes (e.g., Cyclooxygenase-2 (COX-2), Lipoxygenase (LOX), matrix metallopeptidase 9 (MMP9), adhesion molecules (e.g., intracellular adhesion molecule-1 (ICAM-1), vascular cell adhesion molecule-1 (VCAM-1), and endothelial leukocyte adhesion molecule-1 (ELAM-1) apoptosis related proteins (e.g. Bcl-2, caspases) cell cycle proteins (e.g cyclin D1). Curcumin modulates the activity of several transcription factors (e.g NF-kB, AP-1, STAT) and their signalling pathways. However, detailed review in this regard is beyond the scope of this article.

6. Curcumin in Oral Diseases

Curcumin, the most active polyphenolic constituent shows a wide range of beneficial properties. Evidence on the diversified therapeutic approaches of Curcumin for most of the diseases makes it a potential agent to be used in various oral diseases.

1) Aphthous ulcers:

Aphthous ulcers are among the most common oral lesions in the general population. Due to the undetermined etiology of ulcer formation, there is no definite treatment and mainly treatment aimed at relieving the symptoms. It has been observed in various studies that Curcumin showed effective relief of these symptoms due to its anti inflammatory activity (Table 1).
mutations in the genetic material of oral epithelial cells with mutagen associated spontaneous or heredity alterations or of varying etiologies, usually tobacco, characterized by 3) Gingival and Periodontal disease

The clinical signs of gingivitis and periodontitis include changes in the morphology of the affected gingival tissue, which causes loss of teeth. Gingival & Periodontal treatment aims to cure inflamed tissue and reduce the number of pathogenic bacteria. Various studies in this regard suggested Curcumin through its anti-inflammatory, antimicrobial properties make it a favorable agent in the treatment of gingival and periodontal diseases (Table 2).4,5

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Curcumin dosage</th>
<th>Patients</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waghmare P et al</td>
<td>2011</td>
<td>Turmeric mouthwash (10 mg/100 ml of water)</td>
<td>100</td>
<td>Reduction in total microbial count was observed in both the groups</td>
</tr>
<tr>
<td>Mali AM et al</td>
<td>2012</td>
<td>Curcumin mouthwash (0.1% turmeric mouthwash)</td>
<td>60</td>
<td>Curcumin mouthwash can be effectively used as an adjunct to mechanical plaque control</td>
</tr>
<tr>
<td>Muglikar S et al</td>
<td>2013</td>
<td>Curcumin mouthwash</td>
<td>30</td>
<td>They concluded that both Curcumin and chlorhexidine showed significant improvement in clinical features.</td>
</tr>
</tbody>
</table>

Local drug delivery system

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Curcumin dosage</th>
<th>Patients</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suhag A et al</td>
<td>2007</td>
<td>Subgingival irrigation Curcumin (1% solution)</td>
<td>20</td>
<td>The results indicated that Curcumin group showed significant reduction in bleeding on probing (100%) and redness (96%).</td>
</tr>
<tr>
<td>Behal R et al</td>
<td>2011</td>
<td>2% whole turmeric gel</td>
<td>30</td>
<td>The was a significant reduction in plaque index, gingival index, sulcus bleeding index, probing pocket depth, and gain in attachment loss</td>
</tr>
<tr>
<td>Gottumukala SN et al</td>
<td>2014</td>
<td>Curcumin based collagen(50mg/cm²)</td>
<td>60</td>
<td>The results demonstrated that, both the groups (chlorhexidine and Curcumin) produced significant reduction in clinical &amp; microbiological parameters</td>
</tr>
<tr>
<td>Farjana HN et al</td>
<td>2014</td>
<td>Curcuma gel (10gms of curcuma extract)</td>
<td>10</td>
<td>They concluded that application of oral curcuma gel thrice daily for a period of three weeks showed decrease in gingival inflammation.</td>
</tr>
<tr>
<td>Anitha V et al</td>
<td>2015</td>
<td>Curcumin gel (250gm Curcumin+95ml glycerol)</td>
<td>30</td>
<td>They concluded that Curcumin showed a significant difference over chlorhexidine in reducing the microbial &amp; clinical parameters evaluated</td>
</tr>
<tr>
<td>Anuradha B et al</td>
<td>2015</td>
<td>Curcumin gel (Cure next). Each gram contains10mg C. longa extract</td>
<td>30</td>
<td>Significant reduction clinical parameters and gain in clinical attachment level were demonstrated in both the groups.</td>
</tr>
<tr>
<td>Shama V et al</td>
<td>2016</td>
<td>Curcumin gel (Cure next). Each gram contains10mg C. longa extract</td>
<td>20</td>
<td>The concluded that topical application of C. longa extract was effective in the treatment of gingivitis/mild periodontitis.</td>
</tr>
<tr>
<td>Roopa DA et al</td>
<td>2016</td>
<td>Curcumin gel (Cure next). Each gram contains10mg C. longa extract</td>
<td>30</td>
<td>They concluded that the gel containing curcuma longa extract was efficient in treating gingivitis due to its anti-inflammatory property</td>
</tr>
</tbody>
</table>

3) Potentially malignant oral disease

Oral potentially malignant disorders are a group of disorders of varying etiologies, usually tobacco, characterized by mutagen associated spontaneous or heredity alterations or mutations in the genetic material of oral epithelial cells with or without clinical and histomorphological alterations that may lead to oral squamous cell carcinoma transformation. Due to its antioxidant, an anticancerous & anti-inflammatory property Curcumin plays a key role in the treatment of these diseases (Table 3)

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Curcumin dosage</th>
<th>Patients</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rai B et al</td>
<td>2010</td>
<td>Curcumin caplets (900mg Curcumin, 80gm demethoxycurcumin, 20mg bidentmethoxycurcumin)</td>
<td>25</td>
<td>The patients with oral Leukoplakia, showed significant symptomatic relief and also reduction in clinical size of the lesion by treatment with Curcumin.</td>
</tr>
</tbody>
</table>

Oral lichen planus (OLP)

Table 2

Table 3

Leukoplakia

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Curcumin dosage</th>
<th>Patients</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rai B et al</td>
<td>2010</td>
<td>Curcumin caplets (900mg Curcumin, 80gm demethoxycurcumin, 20mg bidentmethoxycurcumin)</td>
<td>25</td>
<td>The patients with oral Leukoplakia, showed significant symptomatic relief and also reduction in clinical size of the lesion by treatment with Curcumin.</td>
</tr>
</tbody>
</table>
4) Head and neck cancer:
Anticarcinogenic activity of Curcumin is multifaceted. In head and neck cancers the use of Curcumin is still in the stage of invitro studies. Lo Tempio MM et al demonstrated that Curcumin caused Growth suppression of HNSCC cell lines with decreased NF-kB activation.\textsuperscript{40} Cohen AN demonstrated Suppression of Interleukin 6 and 8 production in head and neck cancer cells with Curcumin via inhibition of Ikappa beta kinase invitro.\textsuperscript{41}

5) Radiation mucositis
Mucositis is the painful inflammation and ulceration of the mucous membrane, usually as an adverse effect of chemotherapy and radiotherapy for cancer. Curcumin showed remarkable results in the management of mucositis (Table:4)

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>Curcumin dosage</th>
<th>Patients</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elad S \textsuperscript{et al}</td>
<td>2013</td>
<td>Curcumall mouthwash</td>
<td>7</td>
<td>Reduction in compliance criteria for Curcumall mouthwash group</td>
</tr>
<tr>
<td>Saldanha SP \textsuperscript{et al}</td>
<td>2014</td>
<td>Curcumin mouthwash</td>
<td>29</td>
<td>The authors concluded that both mouth washes were individually effective but on comparison turmeric mouth wash was better than saline.</td>
</tr>
<tr>
<td>Rao S \textsuperscript{et al}</td>
<td>2014</td>
<td>Turmeric solution (400mg Curcumin in 80 ml water)</td>
<td>80</td>
<td>They concluded that turmeric solution provided significant benefit by reducing the severity of mucositis</td>
</tr>
<tr>
<td>Patil K \textsuperscript{et al}</td>
<td>2015</td>
<td>Curcumin mouthwash</td>
<td>20</td>
<td>The authors concluded that turmeric mouth wash was better than chlorhexidine gel and there was better patient compliance</td>
</tr>
<tr>
<td>Charantimath S \textsuperscript{et al}</td>
<td>2016</td>
<td>Cure next oral gel (10mg/1gm of C.longa)</td>
<td>40</td>
<td>They concluded that Curcumin gel is effective and safer alternative in treatment of oral mucositis.</td>
</tr>
</tbody>
</table>

Table 4
7. Miscellaneous

a. Pit and fissure sealant: Curcumin through its anti microbial property causes reduction of caries. This sealant can be produced from a composition comprising a polymerizable resin system containing acrylic monomer and group consisting of Annatto extract, turmeric extract and Apo-8-Carotenal.4

b. Intracanal medicament: It has been reported that E. faecalis is the predominant microbe seen in root canal of the infected teeth.45 Curcumin through its anti microbial activity, acts as an intra canal medicament in the endodontic treatment. Neelakantan P 47 et al conducted an invitro study on 30 extracted teeth using Turmeric extract(5% turmeric powder in 10 ml water) and concluded that Curcumin showed antibacterial activity against E. faecalis.similarly, Prabhakar A 48 et al in 2013 conducted an invitro study in 40 extracted tooth and reported 54% inhibition of E. faecalis using Turmeric extract(200gms in 500ml water),proving it to be an efficacious intracanal medicament

8. Adverse Effects

Generally considered safe, but may cause nausea, stomach upset, gastric irritation, diarrhoea & allergic reaction. Singh B et al in 2015 reported allergic contact mucositis in a patient using Curcumin gel, however they concluded that it may be due to the dyes like erythrosine used in the preparation.49

9. Future Challenges

The major concerns with Curcumin are low oral bioavailability that can be attributed to its poor absorption, high rate of metabolism and rapid elimination from the body.47 Therefore, novel strategies using the nanotechnology in drug delivery, Curcumin with other combinations like turmeric oil, piperine & metal complex are being aggressively explored to enhance the bioavailability.48

10. Conclusion

Throughout the human history, there has been a conspicuous concern for health care and the cure of the disease, even though the concepts themselves took a very long time to develop into a body of knowledge. From time immemorial, we have been using Curcumin, in the form of turmeric to attain the state of well-being. Currently, several proven studies clearly suggest that Curcumin has an edge over conventional allopathic treatment that suffer the limitation of low benefit to high risk ratio.51 However, there is less information and research in this field. Therefore, further research is required to determine the optimal dosage, bioavailability, and bio-efficacy of Curcumin drugs.

References

[18] Behal R, Mali AM, Gilda SS, Paradkar AR. Evaluation of local drug-delivery system containing 2% whole turmeric gel used as an adjunct to scaling and root planing in chronic periodontitis: A clinical and


