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## **APPLICATIONS OF TURMERIC IN RESTORATIVE DENTISTRY AND ENDODONTICS: A NARRATIVE REVIEW**

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## ABSTRACT

Turmeric, a member of the ginger family and popularly known as the Golden Spice, has been used for medicinal purposes for approximately 4000 years around the world. Apart from its usage in various industries such as food, cosmetic and the medical field as a traditional remedy, it has also been used in the dentistry due to its pharmaceutical properties. This article aims to emphasize on the vast range of applications of Turmeric in the discipline of Restorative Dentistry and Endodontics.

**KEYWORDS** – Curcuma longa, Endodontics, Turmeric, Restorative dentistry

## INTRODUCTION

Turmeric (*Curcuma longa*) often regarded as Indian saffron, is a rhizome native to Southeast Asia belonging to the Ginger family that has been used as a flavouring agent, a dye and as a natural medicine since thousands of years. It can thus be regarded as a 'Nutraceutical' product, term derived from "nutrition" and "pharmaceutics", which are products that other than nutrition, also offer medicinal properties [1]. Turmeric contains a variety of phytochemicals such as varieties of curcuminoids like diarylpentanoids and diarylheptanoids. The most well-studied of which are 'curcumin' [mix of 3 non-volatile components like diarylheptanoids: the diferuloylmethane (Curcumin-I), the desmethoxycurcumin (Curcumin-II), and the bisdesmethoxycurcumin (Curcumin-III)]. Curcumin has been demonstrated to target several signalling molecules while also displaying cellular activity. Other components include flavonoids and essential oil component containing sesquiterpene ketones like curlone, the turmerones and the zingiberene. The biological effects of turmeric are believed to be mediated by curcuminoids and essential oils. Turmeric includes moisture ( > 9%), Curcumin (5 - 6.6%), extraneous matter (0.5 % by weight), mould ( 3% ) and volatile oils (3.5 % ) in its standard form; which is also a rich source of fatty acids -3 and -linolenic acid.

Since turmeric possesses antioxidant, antimicrobial, anti-inflammatory, astringent, anticarcinogenic and other beneficial properties, thus holding wide scope of utilization in dental

field as well [2-5]. Turmeric being a natural medicinal agent provides therapeutic edge to various dental restorative materials if incorporated constituting the wide range of bioactive restorative material in the field of restorative dentistry. Whereas the foundation for successful endodontic therapy rests on removal of microbes by chemomechanical debridement followed by hermetic seal of root canal space with three-dimensional obturation. In this contemporary era of dentistry, natural alternatives or phytotherapeutics are establishing their place in the domain of endodontics as they offer various advantages over chemical-based therapeutics like:

- (a) Fewer side effects
- (b) Cost effectiveness
- (c) Superior patient tolerance and compliance
- (d) Renewable nature of resource
- (e) Easily available
- (f) Adequate storability

Traditional healers have been using plant components as Folklore medicine since the dawn of mankind. According to WHO, 80% of the world's population mainly relies on traditional remedies. [6]. The applications of turmeric in dentistry have been widely investigated. Thus, the objective of this review is mainly to highlight the spectrum of applications of this golden herb, Turmeric in the contemporary field of restorative dentistry and endodontics.

#### **MECHANISM OF ACTION OF CURCUMIN**

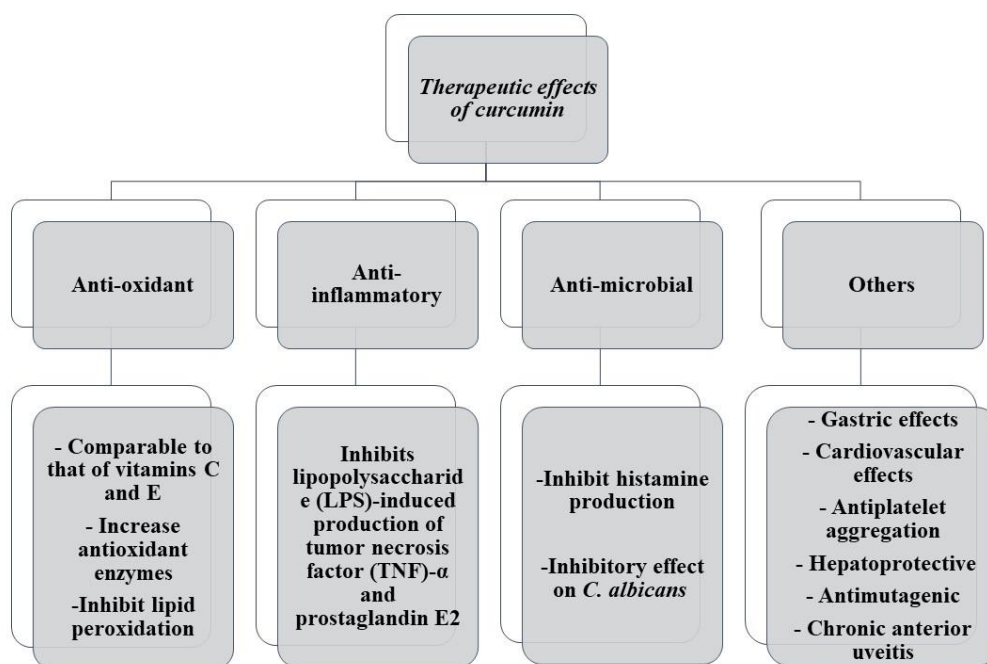


Figure 1

## **APPLICATION OF TURMERIC IN RESTORATIVE DENTISTRY**

### **TURMERIC IN PIT AND FISSURE SEALANTS**

A pit and fissure sealant which helps in prevention of dental caries, if is coloured, considerably enhances the operator's visual perception during application and recall inspection. The composition is made of a polymerizable resin system that contains acrylic monomer and a colorant selected from a list that includes extracts of annatto, turmeric and -Apo -8'- Carotenal to create this sealant. [7].

### **TURMERIC USED FOR CAVITY DISINFECTION**

Curcumin's potential use as a cavity disinfectant was highlighted in a study by Rana Sulaiman Al-Hamdan et. al., where caries affected dentin (CAD) disinfection was carried out using methylene blue photosensitizer (MBP), a fluoride compound like Silver diamine fluoride (SDF) in addition to Ozone (O<sub>3</sub>), chlorhexidine (CHX) and turmeric activated by photodynamic therapy following which bond integrity of the caries-affected dentin bonded to a resin-modified glass ionomer cement (RMGIC) was assessed by measuring shear bond strength and estimation of microleakage. The highest bond strength was observed in cavity disinfected with turmeric photosensitizer bonded to RMGIC (16.42 ± 1.10 MPa) while the

least value was demonstrated with methylene blue photosensitizer ( $9.21 \pm 0.22$  MPa). CAD disinfected with CHX bonded to the resin-modified glass ionomer cement demonstrated lowest microleakage showing a significant difference as compared to the other study groups [8].

## **TURMERIC INCORPORATION IN RESTORATIVE MATERIAL**

### **A) TURMERIC REINFORCED GLASS INOMER CEMENT (GIC)**

Prabhakar AR et. al. reported on the potential impact of addition of both 0.5% and 1% w/w turmeric to GIC with respect to its fluoride release ability, antibacterial effectiveness against *Streptococcus mutans* and physical properties in terms of net setting time, shear bond strength and microleakage without any compromise [9].

### **B) TURMERIC REINFORCED COMPOSITE**

Thefye P. M. Sunthar et. al. assessed the antimicrobial properties of Composite Polyethylene materials when reinforced with Neem and Turmeric to positively conclude on the improvement in effectiveness, with turmeric reporting efficiency against both the gram positive as well as the gram negative strains. On the other hand, while the Neem-based composites showed greater effectiveness against colonization of *C. albicans fungi*, the presence of reinforcing particles in polyethylene compromised the mechanical strength, decreasing the maximum load and more particularly, the elongation [10].

## **TURMERIC AS A DISCLOSING MATERIAL FOR ADHESIVE RESIN AFTER BRACKET DEBONDING**

In fixed orthodontic therapy, the bonding of brackets to the enamel of tooth surface using a resin adhesive is eventually removed completely by debonding on completion of treatment. This is necessary to prevent plaque accumulation, mechanical irritation of the gingiva leading to periodontal problems and discolouration of the residual adhesive. Determining the precise boundaries of the tooth-coloured adhesive on enamel without iatrogenic damage is both difficult and time consuming. Hence, several methods were introduced in order to aid in the adhesive detection procedure and improve operator-sensitivity. A solution of turmeric in combination with methylene blue that efficiently stained composite was identified by Abdallah MN et al. and a media for the staining protocol was reported by Hossein Aghili et.

al. Solution of Persica, an FDA approved herbal mouthwash and fluoride containing GC-MI Plus paste commonly prescribed for fixed orthodontic patients were used as media for turmeric [11-15]. Although the turmeric-GC-MI Plus paste showed significantly higher mean cross-border yellowness than the turmeric-persica solution. (p-value: 0.005), it was considered suitable for disclosing adhesive resin material on tooth surface[11].

## **APPLICATION OF TURMERIC IN ENDODONTICS**

### **TURMERIC AS AN INTRACANAL MEDICAMENT**

Endodontic infections are mainly caused due to microbial contamination of root canal space. The main goal of non-surgical endodontic treatment, therefore is to eliminate pathogenic microbes by appropriate cleaning, shaping of the root canals followed by obturation. But sometimes due to complex root anatomy and the inability to access root intricacies by instrumentation and irrigation, leads to retainment of microorganisms in dentinal tubules which in turn causes chronic endodontic infection. Intracanal dressing is thus used to eliminate any residual microorganisms in the pulp space and provide an atmosphere suitable for reparation of periapical tissues [16-19].

Among intracanal medicaments, the most popular chemical based medicament is calcium hydroxide followed by chlorhexidine and triple antibiotic paste etc. are extensively used but natural herbal products like the *Curcuma longa* are considered to be popular option due to their fewer side effects [16].

Primary endodontic infections being polymicrobial are dominated by Gram-negative anaerobic rods compared to the few bacterial species found in secondary endodontic infections [16-19]. *Enterococcus faecalis*, a gram positive facultative anaerobe, that survives extreme conditions by forming biofilms is the most common bacterial species isolated from root canals of the teeth accounting for 22-77% failed endodontic treatments [6]. An antimicrobial assessment by Vasudeva A et al. (2017) compared seven groups of intracanal medicaments - saline, chlorhexidine, calcium hydroxide, propolis, *curcuma longa*, honey and *aloe vera* and concluded that 2% of chlorhexidine demonstrated the highest antibacterial activity followed by Propolis and *C.longa* without any statistical significant difference and least effectiveness by *Aloe vera* [16]. A similar study comparing natural agents like mushroom, *aloe vera* and turmeric; concluded *curcuma longa* to be the most efficacious in reduction of *E. faecalis* colony counts after 14 days (68.40%) [20].

Saha S. et al. (2015) concluded *C. longa* to have better antimicrobial efficacy than Calcium Hydroxide with the highest efficacy shown by Propolis when agents like Calcium hydroxide, Chlorhexidine and metronidazole combination, Propolis and *C. longa* extract were compared [21]. The in-vitro study by Kumar H. et al. concluded *C. longa* (20%) and Hexigel (CHX-1%) with maximum zone of microbial inhibition when compared with other medicaments like *C. longa* (T<sub>1</sub>-10%), *T. ammi* (A<sub>1</sub>-10% and A<sub>2</sub>-20%) and Calcium hydroxide [6]. Thus *C. longa* has comparable effectiveness as an intracanal medicament to chlorhexidine and has proven to be better than Calcium Hydroxide, thus highlighting its great potential to be researched in detail.

### **TURMERIC AS AN IRRIGANT**

The success of both primary endodontic treatment and failed cases lies in complete eradication of the most common microbial species like *Enterococcus faecalis*, *Candida albicans* and *Staphylococcus aureus* by the process of cleaning-shaping in combination with intracanal irrigants/medicaments [22]. When the antimicrobial effect of *C. longa* was evaluated against *E. faecalis* by measuring the mean zone of inhibition, it was found that 2.5 % Sodium Hypochlorite followed by Propolis, *Azadiracta indica* and Triphala showed better results as compared to *C. longa* which showed similar results to that of *M. citrifolia* [23]. Results from another study by Saxena D et al., reported the antimicrobial effect of 5.25 % Sodium Hypochlorite and *Azadiracta indica* (AI) -Neem to be higher as compared to *Curcuma longa* (CT) – Turmeric when evaluation is done by Real Time Quantitative Polymerase Chain Reaction. *Terminalia chebula* (TC) – Myrobolan showed similar efficacy to *E. faecalis* as *Curcuma longa*. The same study showed higher effectiveness of 5.25% Sodium Hypochlorite and *Azadiracta indica* (AI) -Neem against *C. albicans* followed by *Curcuma longa* (CT) – Turmeric [24]. In the study by Dedhia J et al., it was found that *Andrographis paniculate* and Sodium Hypochlorite had higher zone of microbial inhibition as compared to *C. longa* against *C. albicans* whereas *C. longa* did not show any effectiveness against *Staphylococcus aureus* [25]. When the mean zone of bacterial inhibition (*E. faecalis*) of two different formulations of Turmeric - 50% Aqueous turmeric extract and 50% Hydro-alcoholic extract were measured then it was observed that 50% Hydro-alcoholic extract showed better results [26] in contrast to a study done by Hegde MN et al [27].

Walaa H. Salem et. al. studied the effect of bleached turmeric extract, a topical acne cream as an endodontic irrigant on microhardness of dentin as compared to sodium hypochlorite. Although lowering of chemical properties of its active agents and polyphenols content was

reported, the effect of the hydro-alcoholic extract on dentin microhardness was comparable to that of sodium hypochlorite [28]. Vivian Maria Tellaroli Rodrigues Minhaco et. al. (2023) synthesised a novel polymeric nanoparticle made of poly-lactic-co-glycolic acid (PLGA) loaded with curcumin (NP + Cur) as an antimicrobial agent to target endodontic biofilms following photodynamic treatment. The use of concentration of 325 µg/mL of photo-activated NP+Cur effectively reduced the viability of the endodontic bacteria evaluated in the study [29].

### **TURMERIC AS A STORAGE MEDIA FOR AVULSED TEETH**

Tooth avulsion, described as the complete traumatic displacement of a tooth from the alveolar socket causes a compromised neurovascular supply leading to pulpal necrosis and damage to the periodontium is most commonly reported involving the anterior teeth after an injury due to a fall, sports/traffic accident or an assault [30]. Now as the main objective is to place the avulsed tooth in a suitable media to preserve vitality of the periodontal ligament cells and thus minimize extra-oral dry time, the American Association of Endodontists had recommended Hank's Balanced Salt Solution (HBSS). However, it may not be readily available and hence an alternative medium comparable to HBSS and yet be easily available, inexpensive is required to maintain the viability of cells. The herbal extract of Turmeric when tested in comparison to other easily available agents like milk and neem tested showed relatively inferior results in terms of maintaining cell viability[31].

### **TURMERIC USE FOR VITAL PULP THERAPY**

Vital Pulp Therapy is an important modality for preserving the vitality and functions of the pulp that mainly includes indirect-direct pulp capping or pulpotomy procedure if pulpal exposure is present. There are various chemical-based agents used for pulpotomy but there is a constant search for alternate agents and phytotherapeutics for the same. A study by Hugar SM et al showed 100 % of radiographic success with 86.7 % of clinical success rate with respect to use of turmeric gel as pulpotomy agent in primary molars [32]. A histopathological response of curcumin was compared to MTA after pulpotomy procedure on rats at 7, 14 and 30 days and it was found that both the groups showed significant amount of overall inflammatory cell reduction whereas the dentin bridge so formed after pulpotomy was not consistent in curcumin group as compared to MTA across the various time intervals [33].

### **CONCLUSION**

Turmeric, a popular culinary spice is an effective phytotherapeutic alternative to chemical-based agents. Turmeric or popularly known as Haldi in India utility ranges from a cavity disinfectant, as a therapeutic reinforcing agent added to strengthen various restorative dental materials to its use as a disinfectant of root canal space and its usage as a storage media for avulsed tooth in Restorative Dentistry and Endodontic applications. Nanotechnology-based novel strategies are now being actively explored worldwide to enhance the bioavailability and reduce the perceived toxicity of curcumin. There is wide scope to explore its applications and benefits in dentistry and therefore further long-term research in this field is warranted.

## REFERENCES

1. Nasri H, Baradaran A, Shirzad H, Rafieian-Kopaei M. New concepts in nutraceuticals as alternative for pharmaceuticals. *International journal of preventive medicine*. 2014 Dec;5(12):1487.
2. Rolfe V, Mackonochie M, Mills S, MacLennan E. Turmeric/curcumin and health outcomes: A meta-review of systematic reviews. *European Journal of Integrative Medicine*. 2020 Dec 1;40:101252.
3. Hewlings SJ, Kalman DS. Curcumin: a review of its effects on human health. *Foods*. 2017 Oct;6(10):92.
4. Rahmani AH, Alsahli MA, Aly SM, Khan MA, Aldebasi YH. Role of curcumin in disease prevention and treatment. *Advanced biomedical research*. 2018;7.
5. Meng FC, Zhou YQ, Ren D, Wang R, Wang C, Lin LG, Zhang XQ, Ye WC, Zhang QW. Turmeric: A review of its chemical composition, quality control, bioactivity, and pharmaceutical application. *Natural and artificial flavoring agents and food dyes*. 2018 Jan 1:299-350.
6. Kumar H. An in vitro evaluation of the antimicrobial efficacy of *Curcuma longa*, *Tachyspermum ammi*, chlorhexidine gluconate, and calcium hydroxide on *Enterococcus faecalis*. *Journal of conservative dentistry: JCD*. 2013 Mar;16(2):144.
7. Chaturvedi TP. Uses of turmeric in dentistry: An update. *Indian Journal of Dental Research*. 2009 Jan 1;20(1):107.
8. Al-Hamdan RS. Caries effected dentin disinfection using Ozone, methylthioninium chloride and turmeric activated by photodynamic therapy on bond integrity of resin-modified glass ionomer cement. *Photodiagnosis and Photodynamic Therapy*. 2021 Dec 1;36:102613.

9. Prabhakar AR, Chandrashekar YM, Karuna YM, Mythri P. Effect of Turmeric incorporation on fluoride release, Antibacterial activity and Physical properties of glass ionomer cement An in-vitro comparative study. INTERNATIONAL JOURNAL OF AYURVEDIC MEDICINE. 2014 Jan 1;5(1):91-101.
10. Sunthar TP, Marin E, Boschetto F, Zano M, Sunahara H, Ramful R, Kamei K, Zhu W, Pezzotti G. Antibacterial and ANTIFUNGAL properties of composite POLYETHYLENE Materials reinforced with Neem and turmeric. Antibiotics. 2020 Dec;9(12):857.
11. Aghili H, Golzarian M, Yassaei S, Ebrahimi Z, Moradi Z. Staining ability of turmeric-persica solution and turmeric-gc-mi plus paste on remnant adhesive resin after bracket debonding. Journal of Clinical and Diagnostic Research. 2018;12(9):ZC34-6.
12. David VA, Staley RN, Bigelow HF, Jakobsen JR. Remnant amount and cleanup for 3 adhesives after debracketing. American Journal of Orthodontics and Dentofacial Orthopedics. 2002;121(3):291-96.
13. Abdallah MN, Light N, Amin WM, Retrouvey JM, Cerruti M, Tamimi F. Development of a composite resin disclosing agent based on the understanding of tooth staining mechanisms. Journal of dentistry. 2014;42(6):697-708
14. Sofrata A, Brito F, Al-Otaibi M, Gustafsson A. Short term clinical effect of active and inactive *Salvadora persica* miswak on dental plaque and gingivitis. Journal of Ethnopharmacology. 2011;137(3):1130-34.
15. Huang GJ, Roloff-Chiang B, Mills BE, Shalchi S, Spiekerman C, Korpak AM, et al. Effectiveness of MI Paste Plus and PreviDent fluoride varnish for treatment of white spot lesions: a randomized controlled trial. American Journal of Orthodontics and Dentofacial Orthopedics. 2013;143(1):31-41.
16. Vasudeva A, Sinha DJ, Tyagi SP, Singh NN, Garg P, Upadhyay D. Disinfection of dentinal tubules with 2% Chlorhexidine gel, Calcium hydroxide and herbal intracanal medicaments against *Enterococcus faecalis*: An in-vitro study. Singapore dental journal. 2017 Dec 1;38:39-44.
17. Jayakkodi H, Reddy A, Krishnan V, Arora S, Cv RR, Joseph S. Assessment of Antimicrobial Activity of Different Intracanal Medicaments against *Enterococcus faecalis* and *Candida albicans*: An In Vitro Study. The journal of contemporary dental practice. 2019 Feb 1;20(2):179-83.
18. Shrivastava R, Rai VK, Kumar A, Sinha S, Tripathi P, Gupta K, Sabharwal S. An in vitro Comparison of Endodontic Medicaments Propolis and Calcium Hydroxide alone

- and in Combination with Ciprofloxacin and Moxifloxacin against *Enterococcus Faecalis*. The journal of contemporary dental practice. 2015 May 1;16(5):394-9.
19. Baranwal R, Duggi V, Avinash A, Dubey A, Pagaria S, Munot H. Propolis: A Smart Supplement for an Intracanal Medicament. International journal of clinical pediatric dentistry. 2017 Oct;10(4):324.
  20. Patil V, Akal N, Biradar S, Ratnakar P, Rairam S, Batta O. Comparative evaluation of antimicrobial efficacy of mushroom, Aloe vera, and Curcuma longa with calcium hydroxide as an intracanal medicament against *Enterococcus faecalis*: An in vitro study. Journal of Conservative Dentistry. 2022 Jul 1;25(4):415.
  21. Saha S, Nair R, Asrani H. Comparative Evaluation of Propolis, Metronidazole with Chlorhexidine, Calcium Hydroxide and Curcuma Longa Extract as Intracanal Medicament Against *E. faecalis*—An Invitro Study. Journal of clinical and diagnostic research: JCDR. 2015 Nov;9(11):ZC19.
  22. Dedhia J, Mukharjee E, Luke AM, Mathew S, Pawar AM. Efficacy of *Andrographis paniculata* compared to *Azadirachta indica*, *Curcuma longa*, and sodium hypochlorite when used as root canal irrigants against *Candida albicans* and *Staphylococcus aureus*: An in vitro antimicrobial study. Journal of conservative dentistry: JCD. 2018 Nov;21(6):642.
  23. Saxena D, Saha SG, Saha MK, Dubey S, Khatri M. An in vitro evaluation of antimicrobial activity of five herbal extracts and comparison of their activity with 2.5% sodium hypochlorite against *Enterococcus faecalis*. Indian Journal of Dental Research. 2015 Sep 1;26(5):524.
  24. Vinothkumar TS, Rubin MI, Balaji L, Kandaswamy D. In vitro evaluation of five different herbal extracts as an antimicrobial endodontic irrigant using real time quantitative polymerase chain reaction. Journal of conservative dentistry: JCD. 2013 Mar;16(2):167.
  25. Dedhia J, Mukharjee E, Luke AM, Mathew S, Pawar AM. Efficacy of *Andrographis paniculata* compared to *Azadirachta indica*, *Curcuma longa*, and sodium hypochlorite when used as root canal irrigants against *Candida albicans* and *Staphylococcus aureus*: An in vitro antimicrobial study. Journal of conservative dentistry: JCD. 2018 Nov;21(6):642.
  26. Chaitanya BV, Somisetty KV, Diwan A, Pasha S, Shetty N, Reddy Y, Nadigar S. Comparison of antibacterial efficacy of turmeric extract, *morinda citrifolia* and 3%

- sodium Hypochlorite on *Enterococcus faecalis*: An In-vitro Study. *Journal of clinical and diagnostic research: JCDR*. 2016 Oct;10(10):ZC55.
27. Hegde MN, Shetty S, Yelapure M, Patil A. Evaluation of antimicrobial activity of aqueous and hydro-alcoholic *Curcuma longa* extracts against endodontic pathogens. *IOSR Journal of Pharmacy*. 2012 Mar;2(2):192-8.
28. Salem W, Moussa TA, Abouraya NL. Chemical Characterization of Bleached Turmeric Hydro-Alcoholic Extract and Its Effect on Dentin Microhardness Versus Sodium Hypochlorite as An Endodontic Irrigant: In Vitro Study. *Egyptian Dental Journal*. 2021 Apr 1;67(2):1453-62.
29. Minhaco VM, Maquera-Huacho PM, Imbriani MJ, Tonon CC, Chorilli M, de Souza Rastelli AN, Spolidorio DM. Improving antimicrobial activity against endodontic biofilm after exposure to blue light-activated novel curcumin nanoparticle. *Photodiagnosis and Photodynamic Therapy*. 2023 Feb 10:103322.
30. De Brier N, O D, Borra V, Singletary EM, Zideman DA, De Buck E, International Liaison Committee on Resuscitation First Aid Task Force, Bendall JC, Berry DC, Carlson JN, Cassan P. Storage of an avulsed tooth prior to replantation: A systematic review and meta-analysis. *Dental Traumatology*. 2020 Oct;36(5):453-76.
31. Dhimole P, Bhayya DP, Gupta S, Kumar P, Tiwari S, Pandey S. Evaluation of the efficacy of neem (*Azadirachta indica*) and turmeric (*Curcuma longa*) as storage media in maintaining periodontal ligament cell viability: An in vitro study. *Journal of Indian Society of Pedodontics and Preventive Dentistry*. 2019 Apr 1;37(2):140.
32. Hugar SM, Kukreja P, Hugar SS, Gokhale N, Assudani H. Comparative evaluation of clinical and radiographic success of formocresol, propolis, turmeric gel, and calcium hydroxide on pulpotomized primary molars: A preliminary study. *International journal of clinical pediatric dentistry*. 2017 Jan;10(1):18.
33. Prabhakar AR, Mandroli PS, Bhat K. Pulpotomy with curcumin: Histological comparison with mineral trioxide aggregate in rats. *Indian Journal of Dental Research*. 2019 Jan 1;30(1):31.