Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.47750/jptcp.2023.30.07.049

Zinc Oxide Conjugated Rutin Trihydrate Nanocomposite For Application In Dry Socket

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Submitted: 10 February 2023; Accepted: 18 March 2023; Published: 02 April 2023

ABSTRACT

Background: Dry socket or Alveolar osteitis is one of the most common and unpleasant post operative conditions after the extraction of permanent tooth.Zinc oxide is used for the treatment of dry socket and it is considered to be effective in relieving pain.Rutin trihydrate is also effectively used for antimicrobial activity.

Aim: To formulate and assess the physical, biological and healing properties of Zinc oxide and rutin trihydrate nanocomposites (ZnO-RTn).

Materials And Methods: Nutrient broth (1.3grams) is taken as a culture medium and dissolved in 100ml of water and is sterilized at 120°C. The bone slab is washed in saline and UV exposure is given for 30 minutes.Streptococcus mutans is added.Zinc oxide conjugated rutin trihydrate is added in another beaker and is incubated for 24 hours.SEM analysis is carried out.

Result: The nanoparticle was found to be in triangular shape which gives better surface interaction. The other elements present in the material source are carbon, oxygen, zinc.The cell viability was found to be 76.32%.

Conclusion: Due to the improvised properties of the nanoparticles ,they can find applications in the treatment modalities of various diseases.

Keywords: *Alveolar osteitis,zinc oxide,rutin trihydrate,gel formulation,healing ,antimicrobial effect*

J Popul Ther Clin Pharmacol Vol 30(7):e446–e454; 02 April 2023.

INTRODUCTION

The dry socket condition has been described as the presence of postoperative pain at the site of extraction ,which increases severely after two or three days of extraction,along with partially or totally disintegrated blood clot within the alveolar socket.It is the most common and unpleasant post operative condition, arising as a common complication of traumatic extractions.It is a most studied complication in the field of dentistry (Mouriaux 2022).Local fibrinolytic activity is regarded as the primary cause for dry socket and other causes of dry socket were traumatic extractions tobacco use and oral contraceptives .The incidence of dry socket was found to be approximately 3% for all routine extractions and was found to reach 30% for impacted mandibular third molars.(Deng et al. 2022)Dry socket is a self limiting disease that can disappear within 5 to 10 days without any treatment .Dry socket is characterized by denuded osseous surroundings covered by a yellow gray necrotic tissue layer , and a putrid odor and the pain spreads to the ear and neck.(da Costa et al. 2023)

The treatment of dry sockets depends on the cause and preventive measures. The use of medicated dressing materials ,flushing out of the socket,and surgical interventions are some modes of treatment .The treatment using medicated dressing materials involve the use of zinc oxide and eugenol and alvogyl .The present study was done to evaluate the efficacy of the zinc oxide along with Rutin trihydrate as a gel to reduce the pain caused by alveolitis. (Almushalbn, Albassal, and Harfouch 2022)

The zinc oxide nanoparticle was found to be an effective antimicrobial agent .These nanoparticles were preffered due to their size and larger surface area .Several studies reported that the antibacterial effect of the ZnO NP's depends on the concentration .The ZnO NPs were found to have smaller size and larger surface area that helps them penetrate into the bacterial membrane ,and exhibit antibacterial effect (Daly et al. 2022).The zinc oxide was found to be non toxic which lead to good biocompatibility to human cells ,and the homeostatic mechanisms were found to be more efficient than that of other metals present .The adaptability and stability of the particle lead to its utilization in various biological activity .Due to the size and surface area the nanoparticles were found to have high surface reactivity .(Health Central 2019)

Rutin also known as Vitamin H is a flavonoid present in the plant kingdom .Rutin formulated hydrogels were used as treatment modalities for various diseases. Flavonoid is a phenolic compound that exhibits a wide range of anti allergic, antimicrobial properties and various blood related disorders.The compound was also found to have powerful antioxidant,cytoprotective ,vasoprotective pharmacological properties .Traditionally it was found to aid circulation and it also increases the flexibility of blood vessels .It was proved that it prevents the formation of blood clots . (Rokohl et al. 2022)Rutin trihydrate is used for topical treatment of inflammation .The compound was found to have anti inflammatory and anti apoptotic effects .

The present study aimed at evaluating the healing and antimicrobial effect of ZnO and rutin trihydrate nanocomposites and its application in the treatment of dry socket.

Our team has extensive knowledge and research experience that has translate into high quality publications (Chaudhari 2020),(Thamizhanambi et al. 2022; Merchant et al. 2022)(Sivarajan et al. 2020) (Thamizhanambi et al. 2022; Merchant et al. 2022; Sathish et al. 2021) (Subramaniam and Muthukrishnan 2021) (Babu et al. 2022)

MATERIALS AND METHODS

Preparation of extract

In 100 ml of distilled water zinc nitrate (1.2 mM solution) was added and dissolved. Rutin trihydrate 0.5 ml was added to this solution and heated at 80 degree Celsius for 2 h.

The process was halted when a mild color change was observed (it turns into whitish yellow color) and solution was allowed to cool down.

Antibacterial analysis using bone slab

Nutrient broth was taken as culture medium (1.3 grams) and dissolved in 100ml of water and sterilized at 120 degree Celsius for 20 minutes .Fresh bone slabs were purchased from the local market and were cut into small pieces and were added to 100ml of sterilized broth.

The bone slab was washed with saline and UV exposure was given for 30 minutes .

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In one flask bone slab containing culture medium is taken along with the Streptococcus mutans and in another flask culture medium containing ZnO-RTn was taken.It was left for 24 hours for incubation

Determination of Antibacterial Activity

The SEM Analysis was carried out for investigating the nanoparticle morphology and to detect the bacterial growth in the bone slabs taken .

The sample was washed with 2.5% glutaraldehyde .Streptococcus mutans an anaerobic gram positive bacteria was taken in one disk along with the bone slab .The nanoparticle formulation was added to it and the bacteria were allowed to grow to detect the presence of antimicrobial activity shown by the nanoparticle formulation.

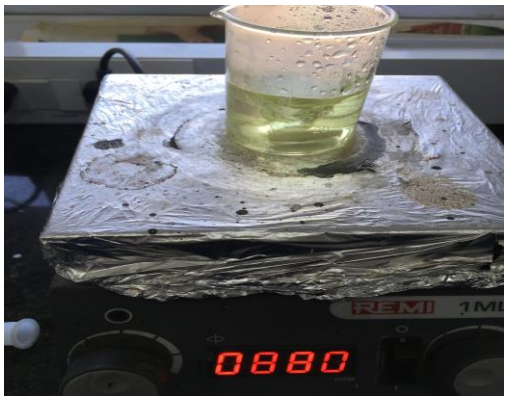

FIGURE 1: The Zinc nitrate Rutin trihydrate nanoparticle is allowed to boil for 2 hours at 80℃

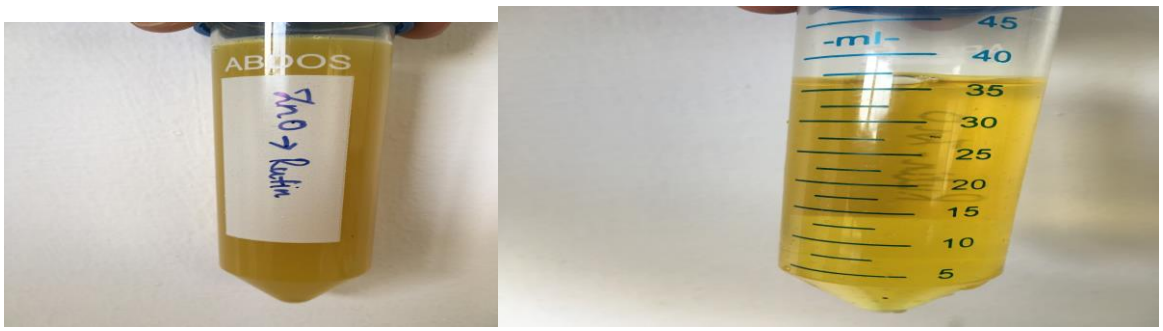

FIGURE 2: Represents the nanoparticle left for 2 hours to observe mild color change .

FIGURE 3: The cut bone slab pieces taken in two different plates in which the control represent the bone slab piece not treated with the nanoparticle and the sample represents the bone slab pieces treated with nanoparticles.

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RESULT AND DISCUSSION

The size of the nanoparticle was found to be triangular and nanoblisters were found in it .The other elements found in the material source were carbon ,oxygen and zinc.The presence of Carbon was found to be 7.5% ,Oxygen was found to be 16.4 %,Zinc was found to be 11.6%.The presence of oxygen enhanced the antimicrobial activity.The oxygen molecules released resulted in the non viability of the bacterial species.The Oxygen molecules present in the nanoparticle helps in scavenging the bacterial cells,the oxygen molecules help in penetrating the bacterial cells and thus killing the bacterial cells .

The viability of cells was found to be 76.32%,if the cell viability decreases below 70% it is said to be toxic. UV spectrometry was carried out which confirmed the presence of nanoparticles at 361 nm .The Zno nanoparticle can absorb a high amount of UV light which in turn provides better surface interaction with the bacterial species.This UV light interaction also can produce oxygen molecules .(Alharbi et al. 2023)

The size of rutin trihydrate was found to be 50 nm which when compared to the previous studies was more ,this is an advantage of the nanoparticle that helped in better surface interaction.Previous studies have shown that the minimum concentration of rutin trihydrate is sufficient to minimize the growth of bacteria.Rutin trihydrate is a phenolic compound that has antimicrobial activity,anti inflammatory activity and enzyme inhibition activity .The studies have shown that the previous hydrogel formulations prepared from the Rutin trihydrate compound were better healents for treating diseases and better absorption than conventional creams and had better patient compliance(Yan et al. 2023) .The hydrogels were found to have better moisturizing properties and therefore caused less dryness (Sun, Sun, and Zhao 2022).This was an added advantage to the present study and thus it can be used for the treatment of dry socket .Rutin trihydrate also showed antimicrobial activity against the gram positive and gram negative bacteria. (Thorat and Nilesh 2022)

Dry socket is an important clinical condition. Microorganisms like Treponema denticola , Actinomyces viscosus,Streptococcus mutans were also found to be a cause for dry socket and its delayed healing .(Quercus Corporation 1976). The use of various gel formulations like Zinc oxide eugenol ,Alvogyl,Vitamin C,Topical anesthetic gel oral were used ,even though these gels were effective ,the zinc oxide eugenol was found to be more sustainable for a longer period of time,it was also found to give quick relief .The antiseptic and anesthetic properties of the Zinc oxide eugenol were found to reduce the pain receptors thereby providing quick relief to pain.(Alhoqail et al. 2023) This finding from the previous study was found to be on par with the present study and further confirms that the nanoparticle formulations are effective .The size of the nanoparticle was an advantage to the study.the ZnO nanoparticles were characterized by their size and morphology,these features allowed the nanoparticle to interact in an unique manner with the microorganisms,and thus exhibiting good antimicrobial effect.(Awwad 2013)The previous studies also found that the reduced size of the nanoparticle shows increased antimicrobial activity and the ZnO NP's are non toxic to humans ."The antimicrobial mechanisms of the nanoparticles are attributed to their large surface area and small size" , the small size helped the nanoparticle to penetrate the bacterial cell wall thus increasing the antimicrobial property. Similarly in the present study the shape of the ZnO NP was found to be triangular and the presence of nuclear blisters were seen which helped in better surface interaction in the embedded region .The ZnO formulated gel was cost effective and easily available dressing material and required a lesser number of dressing .(Abdollahi 2012; Cheng et al. 2023)

The bones slabs were taken in two disks in which one disk of bone slabs were treated with the nanoparticle and the other disk was not treated with the nanoparticle .The disk which was treated with the nanoparticle showed less microorganisms growth that is the nanoparticles showed effective antimicrobial activity .The nanoparticles reduced the activity of the Streptococcus mutans which were previously added in the bone slab .(Lin et al. 2023)

The previous studies have shown that the abrasive surface texture of the nanoparticles improved the antibacterial property. The present study has also proved to show a similar surface texture which was an added advantage to the study.The interfacial potential of the nanoparticle also plays a major role in bringing changes to the viability of the bacterial cells .The interfacial

potential for the bacterium showed changes on increasing the concentration of the nanoparticle.

Although the nanoparticle formulation of the metals were found to be toxic at certain concentrations ,the optimum level of the nanoparticle showed no toxicity , but when taken below 1mm of concentration exhibited lesser antimicrobial properties. (Nahhas 2019)

Previous studies have shown that the nanometers of the nanoparticle showed better antimicrobial activity than that of the microcrystalline nanoparticle,and also the antimicrobial property of the nanoparticle can occur due the rupture of cell wall of the bacterial species .The ZnO nanoparticle was also preferred because of its inorganic nature as the organic antimicrobial agents were found to be less stable and the inorganic metal oxides were found to be more effective and stable .The ZnO NP were also photocatalytic.(Awasthi 2021)

The nanoparticles were found to be effective in inhibiting both gram negative and gram positive bacteria .The Nanoparticle formulation exhibited high antimicrobial activity even at high temperature and high pressure. Even Though the shape and structure of the Nanoparticle was found to be advantageous the concentration of the nanoparticle had prime importance in the study as lesser concentrations were found to exhibit lesser antimicrobial activity.(Galvan 2020)

The antimicrobial activity of the nanoparticle was tested using the SEM Analysis.The SEM images of the nanoparticle indicate that there is clumping of the particles and there is membrane rupture

In this study the SEM Analysis carried out indicates that there is damage to the cell wall of the bacteria due to the direct interaction that occurred between the nanoparticle and the bacterial cell wall ,the interaction also indicates that there is increase in surface tension .Thus the present study proves that when the nanoparticle is formulated as a gel it can provide better and ,quick healing property which can also be sustainable.

The study also inferred the antimicrobial effect of ZnO and rutin trihydrate and the nanoparticle was found to have better properties when compared to the previous studies.

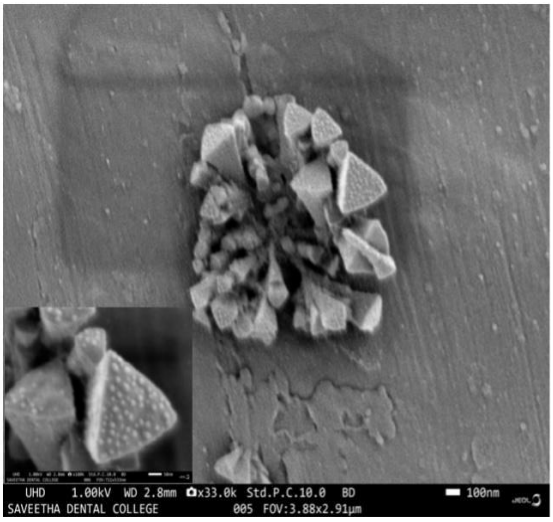

FIGURE 4 : This image represents the trigonal morphology of the ZnO Rutin trihydrate nanoparticle and the presence of blisters can be observed on it which provides better surface interaction.

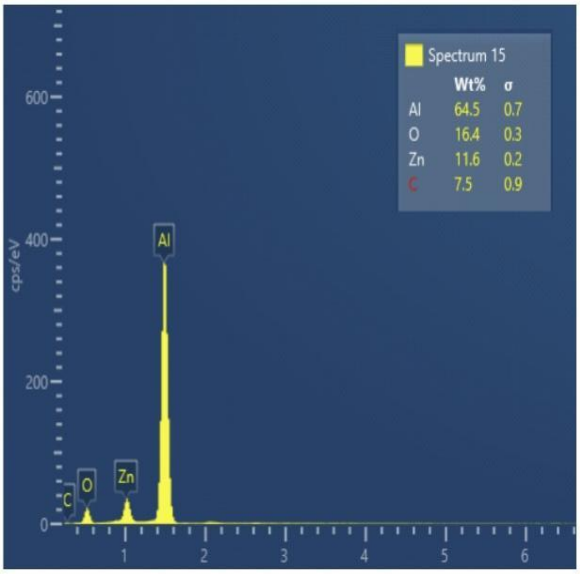

FIGURE 5: The above graph shows the presence of different components present along with the nanoparticle,Carbon which was found to be 7.5% ,Oxygen concentration was 16.4% ,Zinc 11.6 % in concentration, the presence of Aluminium(64.5%) in the study was because of the foil used in wrapped the nanoparticle.

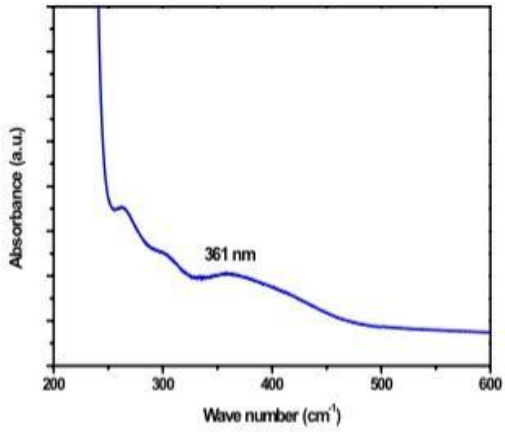

FIGURE 6 : The above image represents the UV Spectrometry performed in the study which confirms the presence of the nanoparticle at 361 nm.

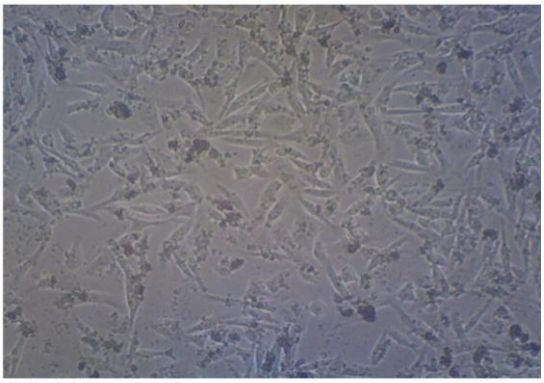

FIGURE 7: The SEM image of the cell viability that was performed ,which shows that the viability of the cells was 76.32 % .If the viability of the cell was found to be less than 70% it is said to be toxic

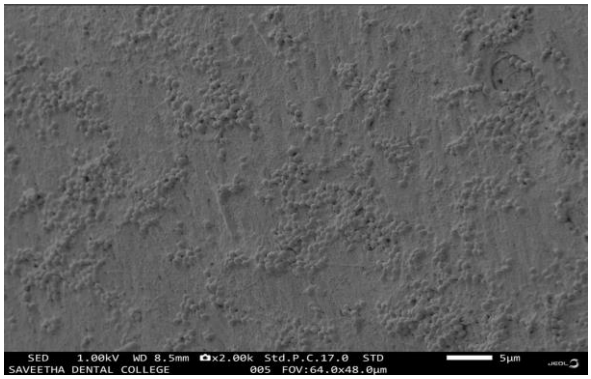

FIGURE 8: The SEM image of the bone slab not treated with the nanoparticle that shows excessive microbial growth.

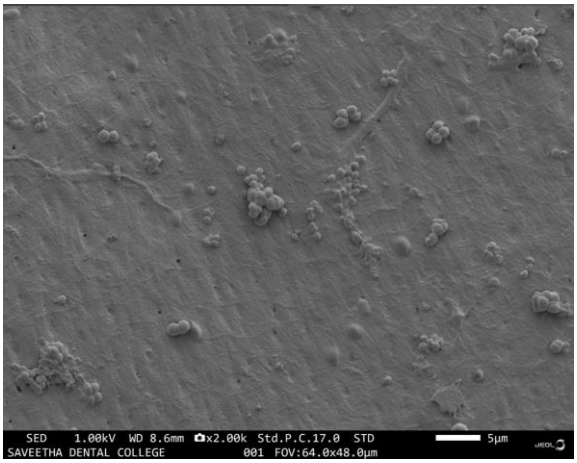

FIGURE 9: The SEM image of the bone slab treated with the nanoparticle ZnO Rutin trihydrate that shows reduced microbial growth that indicates the effectiveness of the nanoparticle in exhibiting antimicrobial resistance.

CONCLUSION

This is a first kind of a study which projects the nano formulation that can be utilised for the treatment of dry socket,due to the improvised property of the nano material they can find application in the treatment modalities of other diseases also .

FUTURE SCOPE

After proper animal study we would like to formulate the compound as a gel and use it for the treatment of severe dry socket in people .

CONFLICT OF INTEREST

There is no conflict of interest

FUNDING AGENCY

Self-funded

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