Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 7s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Novel synthesis of Azadirachta indica and Chamaecostus cuspidatus formulation mediated calcium oxide nanoparticles incorporated in suture material

T Arun Raaj[1], Subhashree. R*[2], S Rajeshkumar[3], Thiyaneswaran N[4], Sahana Selvaganesh[5]

[1]Post Graduate Resident, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai.

[*2]Reader, Department of Implantology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai.

[3]Professor, Department of Nanobiomedicine, Saveetha medical College and Hospital, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai.

[4]Professor and Head, Department of Implantology, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai.

[5]Assistant Professor, Saveetha Dental College, Saveetha Institute of Medical & Technical Sciences, Saveetha University, Chennai, India

Corresponding Author:

Email ID: Subhashreer.sdc@saveetha.com

Cite this paper as: T Arun Raaj1, Subhashree. R, S Rajeshkumar, Thiyaneswaran N, Sahana Selvaganesh, (2025) Novel synthesis of Azadirachta indica and Chamaecostus cuspidatus formulation mediated calcium oxide nanoparticles incorporated in suture material. *Journal of Neonatal Surgery*, 14 (7s), 451-463.

ABSTRACT

Background: Suturing for a patient with diabetes undergoing dental implants or any other surgical procedure requires careful consideration and management to prevent complications. Diabetes can affect wound healing and increase the risk of infection, so it's important to take certain precautions when suturing a diabetic patient.

Aim: To access the antimicrobial, anti-inflammatory, antioxidant, cytotoxic and embryonic toxicology properties of *Azadirachta indica* and *Chamaecostus cuspidatus* formulation mediated calcium oxide nanoparticles incorporated in suture material.

Materials and methods: The plant extracts of *Azadirachta indica* and *Chamaecostus cuspidatus* formulation mediated calcium oxide nanoparticles incorporated in suture material. This suture material was subjected to antimicrobial, anti-inflammatory, antioxidant, cytotoxic and embryonic toxicology assays. Further, the nanoparticles were characterized using a U-V visible spectrophotometer.

Results: The formed nanoparticles showed the highest zone of inhibition for *Enterococcus faecalis*, followed by *Candida albicans* and *Staphylococcus aureus*, whereas *Pseudomonas* had a lower zone of inhibition. They also possess anti-inflammatory, and antioxidant activity and also prove to be biocompatible. It showed no malformation in embryonic toxicology.

Conclusion: The insulin-coated suture material is a type of medical device that combines two functions: suturing of tissues and delivery of insulin. Diabetes patients often require surgical procedures, and this device aims to simplify the post-operative management of these patients.

Keywords: *Suture material coating, Herbal extract, Azadirachta indica, Chamaecostus cuspidatus, calcium oxide nanoparticle, dentistry, implantology.*

1. INTRODUCTION

The concept of insulin-coated suture material is an emerging technology that has the potential to provide localized insulin delivery to diabetic patients during surgery. The idea is to coat the suture material with insulin, which is slowly released into the surrounding tissue over time, helping to regulate blood sugar levels.(Thomas *et al.*, 2022)

Since tooth loss is quite common and can be caused by trauma, disease, and other circumstances, the use of dental implants to support tooth restoration has a long and complicated history.(Gulati, 2023) As more people lose teeth, dental implants are becoming more and more common. Success rates are often good despite the contaminated surgical environment in which they are performed. To promote positive and successful healing while minimizing problems like infection, wound closure is a crucial component of healing after surgical procedures.(Percival and Cutting, 2010) For the purpose of stabilizing and fastening detached tissues for eventual successful healing, sutures, surgical clamps, and adhesive substances are used. Suturing is the best technique now available for optimal wound closure without impairing the physiological components of wound healing, despite being a time-consuming and technique-sensitive part of surgical procedures. Suture materials should ideally be biocompatible, cause few tissue responses, and provide adequate strength throughout the crucial healing phase. These substances are divided into bio-absorbable and nonabsorbable braided multifilament and monofilament materials. The qualities of the needle and thread influence how well a surgical procedure heals wounds. The dentistry sector today offers a wide variety of suturing supplies. However, the choice of suture material for implant or periodontal surgery is frequently based on preferences rather than scientific evidence and has not been thoroughly studied.(Chan and Velasquez-Plata, 2022)

Diabetes is a term used collectively for a number of metabolic disorders that impair glucose metabolism in the body.(Oguntibeju, 2014) Insulin is produced by the pancreas and aids in controlling blood glucose levels. Low insulin levels caused by diabetes can cause high and low blood sugar levels, which can lead to a variety of health issues, including eye loss, renal illness, and nerve damage.(He *et al.*, 2023) Diabetes patients have a higher risk of developing gingival disease and losing their teeth than healthy individuals do. Although dental implants seem like an excellent option for diabetics who are missing teeth, there are a few issues to take into account. Dental implants have important advantages that make them essential for the care of a variety of patients, including the rising number of people with diabetes mellitus.(Katiyar, 2021) Although it has been demonstrated that uncontrolled diabetes might affect some components of the healing process, a high success rate can be achieved when dental implants are inserted in diabetic individuals whose condition is under control. Infection risk is typically higher for patients with diabetics than for non-diabetics.(Draznin, 2016) Because of the disorder, the body's capacity to fight infection is slowed. This explains the higher risk of gum disease and might possibly explain an infection following surgery. Since oral surgery is required to place dental implants, diabetics are more likely to develop postoperative infections. In addition to the risk of infection, some diabetics with poorly managed or unmonitored conditions run the risk of failing dental implants.(Burnier, 2023) In certain situations, post-operative recovery may be slower or inadequate, which prevents the implants from fusing with the oral tissues.(Bonanthaya *et al.*, 2021) In such circumstances, dental appliances cannot be supported by the implants.

Antimicrobial characteristics of calcium oxide nanoparticles have been demonstrated, and they may also have potential uses in drug delivery and tissue engineering. Calcium oxide nanoparticles can be used in tissue engineering to create scaffolds for growing new tissue or repairing damaged tissue.(Khan *et al.*, 2023) The nanoparticles can enhance the structural integrity of the scaffold and promote cell attachment and growth. Calcium oxide nanoparticles have been shown to have potent antimicrobial activity against a range of bacteria, viruses, and fungi.(Rao, Müller and Cheetham, 2006) This makes them a promising candidate for use in wound dressings, disinfectants, and other medical applications where microbial control is important.

Plants have been used extensively throughout history to cure a variety of human diseases. Many plant species include elements that can be used as medicines in one or more of their organs. By definition, these are what the World Health Organization (WHO) refers to as therapeutic plants. *Azadirachta indica*, commonly known as neem, is a tree native to India and other parts of Asia. It is a highly valued medicinal plant with a long history of use in traditional medicine.(Puri, 1999) The leaves, bark, and seeds of the neem tree contain a variety of biologically active compounds, including flavonoids, terpenoids, and alkaloids, which have been shown to have antimicrobial, antifungal, anti-inflammatory, and immunomodulatory properties.(Kumar, Mulchandani and Das Sarma, 2022) Neem is used in traditional medicine to treat a variety of conditions, including skin disorders, fever, and gastrointestinal disorders.(Lakshmi *et al.*, 2015) Neem is an Indian-native evergreen tree in the Meliaceae family that has been used for thousands of years in Ayurvedic medicine. Due to its medicinal properties, the neem tree is frequently referred to as a "village pharmacy," notably in India, and was named "The tree of the 21st century" by the UN.(Koul and Wahab, 2007) Although traditional systems of medicine use neem in many different ways, the toxicities of its natural compounds are crucial before its application as a therapeutic drug.

Chamaecostus cuspidatus, also known as the insulin plant, is a plant native to South America.(Ponnanikajamideen *et al.*, 2019) It is a member of the ginger family and has been traditionally used to treat diabetes. The leaves of the insulin plant contain a variety of biologically active compounds, including flavonoids, alkaloids, and terpenoids, which have been shown to have anti-diabetic properties.(Tyler, 2020) Research suggests that the insulin plant may help to regulate blood sugar levels in people with diabetes by stimulating insulin production or enhancing insulin sensitivity.

Both neem and insulin plants have been studied for their potential use in the management of diabetes, although the mechanisms of action and effectiveness vary. Neem has been shown to have hypoglycemic effects, potentially by increasing insulin sensitivity and enhancing glucose uptake in cells. Insulin plant has also been shown to have hypoglycemic effects, potentially stimulating insulin secretion and improving glucose utilization in cells. While further research is needed to determine the safety and efficacy of these plants for diabetes management, they hold promise as potential natural remedies for this common and challenging condition. Various surgical considerations, including suture techniques, flap design, and treatment planning, may impact the success of dental and craniofacial implant procedures(Prasad and Sivakumar, 2022; Bhalerao *et al.*, 2023; Sreenivasagan, Subramanian and Chae, 2023; Felicita and Khader, 2024).

The suture material is used to close wounds and incisions in surgical procedures, and coatings on sutures can provide additional benefits such as antimicrobial activity, reduced inflammation, and improved wound healing. Calcium oxide nanoparticles and the extracts from *Azadirachta indica* and *Chamaecostus cuspidatus* have all shown potential for wound healing and antimicrobial activity, which may make them suitable candidates for coating suture material.

2. MATERIALS AND METHODS:

1. Preparation of plant extracts:

1mg each of *Azadirachta indica* leaf powder and *Chamaecostus cuspidatus* extract powder is combined with 100ml of distilled water. On a heating mandrel, this solution was heated for 10 to 15 minutes at 50 to 60 degree Celsius. Filtration was used to purify the solution using Whatman filter paper no. 1. The supernatant was collected in a conical flask, and the residue that had been gathered in the filter paper was discarded. (figure 1 and 2)

Figure 1: Preparation of herbal extract: powder of *Azadirachta indica* and *Chamaecostus cuspidatus* plant and calcium carbonate powder.

2. Preparation of nanoparticles:

In the process of making nanoparticles, 50 ml of distilled water was combined with 0.511 grammes of calcium carbonate. 50 ml of filtered plant extract was added to this solution and stirred on an orbital shaker for 24hrs to ensure that all the particles were mixed thoroughly. On a magnetic stirrer, the reaction mixture was constantly swirled until a colour change was visible. By using UV-vis spectroscopic spectroscopy, the formation of nanoparticles was tracked every hour. Calcium oxide nanoparticle's colour change on a UV-vis spectrophotometer indicated that they formed at a certain wavelength. The mixture was collected in 5 test tubes after spectroscopic analysis, and the calcium oxide nanoparticles were separated from the solution using centrifugation for 20 minutes. (figure 1 and 2).

Figure 2: filtration of plant extract

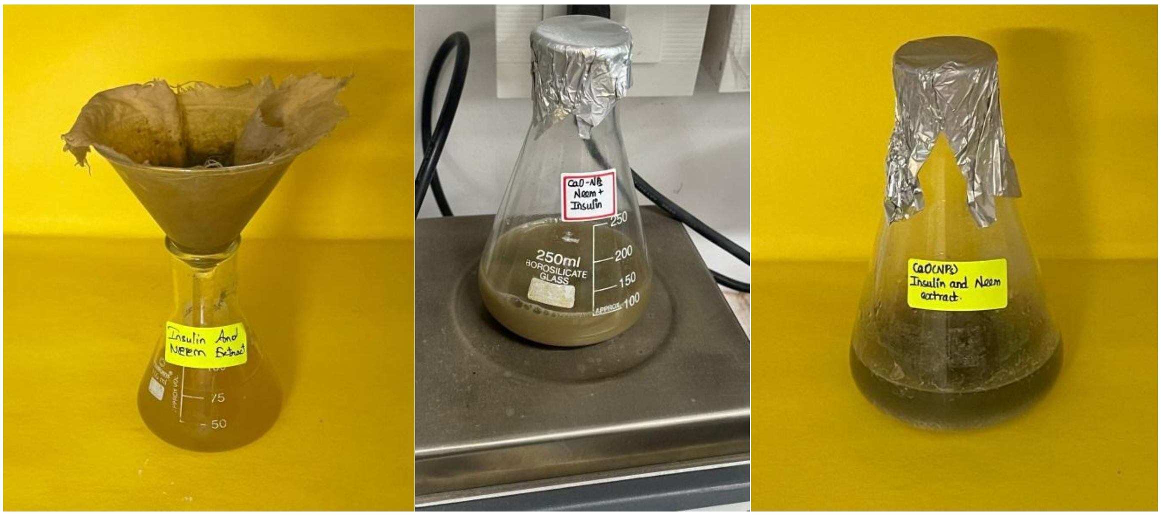


Figure 3: filtration of plant extract

3. Characterization of nanoparticles:

The prepared solution was acquired through the magnetic stirring of the dissolution. The decrease of calcium in the collected solution was then monitored using UV-vis spectroscopy at intervals of 1, 18, 24, and 36 hours. The measured wavelengths ranged from 200 to 600 nm. Additionally, a colour shift was witnessed and noted.

4. Cytotoxicity activity:

BRINE SHRIMP LETHALITY ASSAY

Saltwater preparation:

To dissolve 2g of iodine-free salt, 200 ml of purified water was used.

To 6 well ELISA plates, 10–12 ml of salt water was added. Ten nauplii were injected progressively into each well, receiving (20 l, 40 l, 60 l, 80 l, and 100 l). *Azadirachta indica* and *Chamaecostus cuspidatus* were next introduced in various concentrations of calcium oxide nanoparticles. The plates underwent incubation for 24 hours. Following a 24-hour incubation period, the ELISA plates were examined, numbered, and the presence of live nauplii was determined using the formula below:

number of dead nauplii/number of dead nauplii + number of live nauplii x 100

Figure 4 : ELISA wells with the nauplii.

5. Antimicrobial activity:

Staphylococcus aureus, Enterococcus faecalis, and *Pseudomonas* strains are all susceptible to the antibacterial properties of the respective nanoparticles. The zone of inhibition was located for this experiment using MHA agar. Muller Hinton Agar was prepared and sterilized at 120 lbs for 45 minutes. The material was loaded onto sterile plates, which were then left to set. After using the good cutter to cut the wells, the test organisms were swabbed. The plates were subsequently treated for 24 hours at 37°C with various amounts of calcium oxide nanoparticles. Following the incubation time, the zone of inhibition was evaluated.

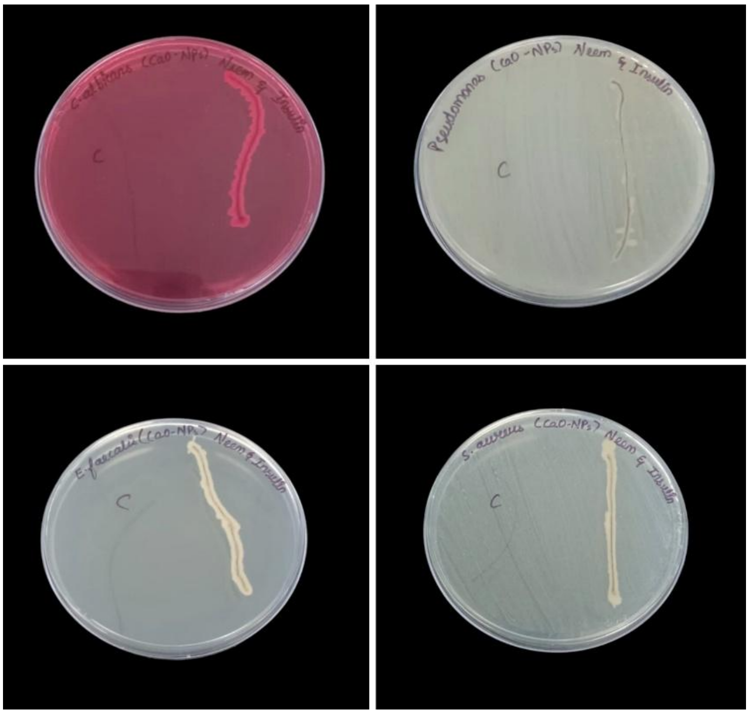


Figure 5: Anti-microbial and anti-fungal activity

6. Antifungal activity:

Candida albicans are examined using agar well diffusion tests. Sabouraud's Dextrose agar is used to create the medium. After swabbing test organisms into the sterilized, prepared media, calcium oxide nanoparticles were introduced to the wells in a range of doses. The plates were incubated at 28 °C for 48–72 hours. After the incubation time, the zone of inhibition was evaluated.

7. Anti-inflammatory activity:

EGG ALBUMIN DENATURATION ASSAY:

2.8 ml of freshly made, pH-6.3 phosphate-buffered saline and 0.2 ml of hen's egg albumin extraction were combined to make a 5 ml solution. Different concentrations of calcium oxide nanoparticles (10 L, 20 L, 30 L, 40 L, and 50 L) were synthesized for *Azadirachta indica* and *Chamaecostus cuspidatus*. Diclofenac sodium was used as a positive control. The mixtures were then heated to 37 °C for 15 minutes in a water bath. After allowing the samples to cool to room temperature, absorbance at 660 nm was assessed.

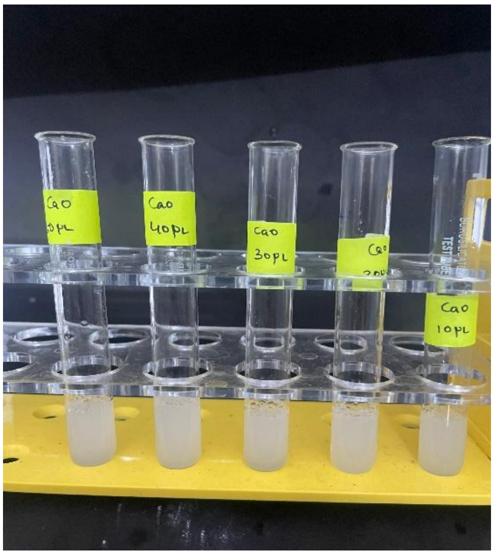


Figure 6: Anti inflammatory activity

8. Antioxidants activity:

HYDROXYL RADICAL SCAVENGING ASSAY:

The Halliwell method [Halliwell et al., 1987] was slightly modified to experiment. Every remedy was created from nothing. The reaction mixture, which had a volume of 1.0 mL, contained 200 mL of 200 mM Fecl3, 1.04 mM EDTA (1:1), 500 mL of a solution of various concentrations of *Azadirachta indica* and *Chamaecostus cuspidatus* in calcium oxide nanoparticles, and 100 mL of 28 mM 2-deoxy-2-ribose (dissolved in phosphate buffer with a pH of 7.4). (1.0mM). After an hour of incubation at 37°C, the deoxyribose breakdown was measured using the TBA reaction. Calculate the absorbance at about 532 nm using the reference absorbance of a blank solution.

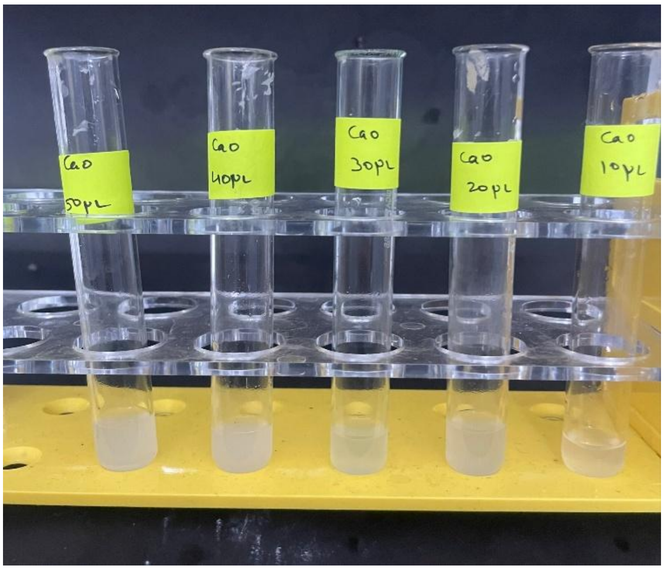
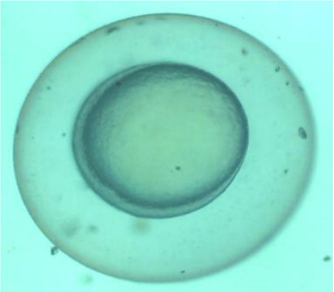


Figure 7: Antioxidant Activity

9. Embryonic Toxicology:

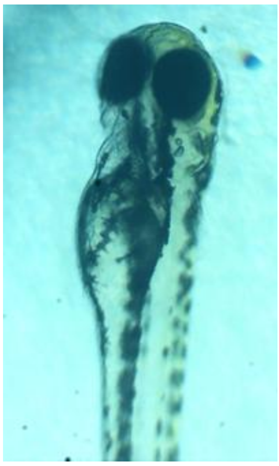
Zebrafish (Danio rerio) were bought from Chennai-based vendors and housed in separate tanks at a temperature of 28°, with a light cycle of 14 hours and a dark cycle of 10 hours, with a pH range of 6.8 to 8.5. The fish were fed dry flakes and shrimp twice a day. For the duration of the entire night, a transparent block was physically utilized to separate the men and females; it was then removed in preparation for reproduction the following morning. To create the fish embryos, one female fish was crossed with two male fish. The viable eggs were collected and rinsed in the E3 medium (5 mmol/L sodium chloride, 0.18 mmol/L potassium chloride, 0.33 mmol/L calcium chloride, and 0.33 mmol/L magnesium sulphate).

The fertilized eggs were shifted to the culture plate. The experimental and control groups were separated. The fertilized embryos were incubated in calcium oxide nanoparticle concentrations ranging from 5, 10, 20, 40, and 80 L for 24 to 96 hours. The experimental group of 5 fish was subjected to various CaO Nanoparticle concentrations for 96 hours. Every 24 hours, the viability and hatching rate was noted. Additionally, 5 fish were kept as control groups. If any of the fish were dead, it was noted and they were taken out. The zebrafish embryo's development during its early stages was monitored periodically during the exposure to the CaO nanoparticle under a stereo microscope. Assessment of the embryo hatching rate, larva viability, and the developmental toxicity was the experiment's prime objective. The developing embryos were captured on camera with a stereomicroscope.



Day 1

Day 2



Day3

Figures 8: Embryo development in different time intervals with CaO nanoparticles

3. RESULTS AND DISCUSSION

1. UV-Vis spectra analysis -

Using UV-Vis spectroscopic analysis, which primarily relies on surface plasmon resonance (SPR), which is used to detect the material adsorption onto the surface of metal nanoparticles, the optical characteristics of the synthesized CaO nanoparticle were investigated. The surface plasmon resonance of the CaO nanoparticles made by A. paniculata is depicted in Figure 9. The size, type, and dielectric constant of the metal nanoparticles as well as the medium all affect how wide the plasmon peak is. The spectra, which showed the characteristic of the titanium dioxide nanoparticles' SPR band between 300 nm, served as the initial confirmation of the nanoparticles' presence.

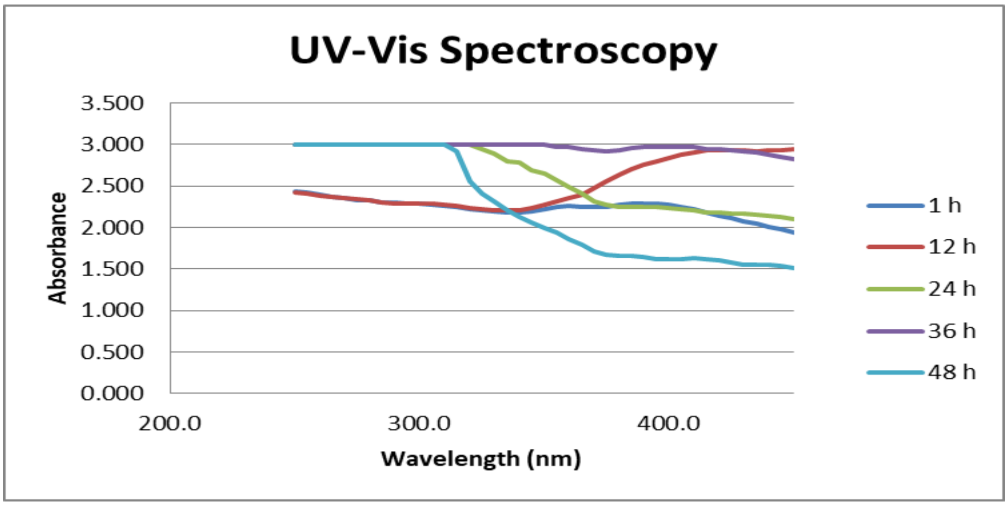


Figure 9 : Result of UV – vis spectroscopy

Cytotoxicity activity:

According to the findings, there were 10 live nauplii at 5µL and 10µL concentrations but only 7 at the greatest concentration of 80µL as shown in figures 10. This demonstrates that the cytotoxicity increased as the CaO nanoparticle concentration with herbal plant extract increased. When the concentration was raised, it revealed a dose-dependent reduction in the number of live nauplii. The percentage of live nauplii that were inhibited at various concentrations of calcium oxide nanoparticles mediated by *Azadirachta indica* and *Chamaecostus cuspidatus* formulation was as follows: 5 µL and 10 µL inhibited 0% of live nauplii, 20µL inhibited 10% live nauplii, 40µL inhibited 20% live nauplii, and 80µL inhibited 30% live nauplii.

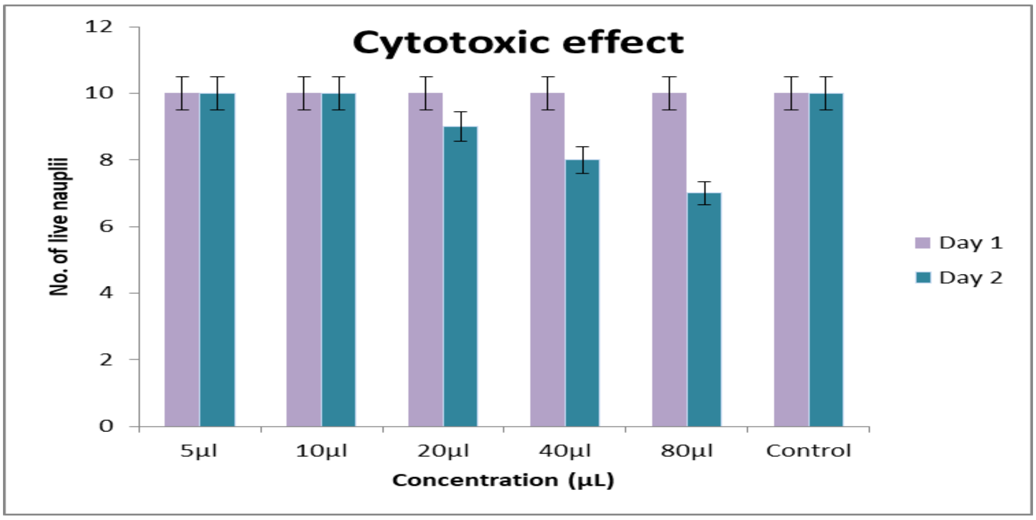


Figure 10: The bar graph depicts the number of nauplii present in different concentrations of *Azadirachta indica* and *Chamaecostus cuspidatus* formulation-mediated calcium oxide nanoparticle; the Y axis represents the frequency of nauplii alive; the X axis denotes the concentration of nanoparticles(µL).

Antimicrobial & Antifungal activity:

NPs coated with suture material:

The antibacterial and antifungal activity of CaO nanoparticles is shown in Figures 11. *Enterococcus faecalis* had the highest zone of inhibition, followed by *Candida albicans* and *Staphylococcus aureus*, whereas *Pseudomonas* had a lower zone of inhibition. It demonstrates that the CaO nanoparticle increased the zone inhibition. In millimetres, the zone of inhibition was measured. Bacterial growth is substantially inhibited by calcium oxide nanoparticles. Candida albicans were used as the test subject for the antifungal activity. It demonstrates that at 100µL, the zone of inhibition was larger. According to a different study, AgNPs' antibacterial efficacy against Pseudomonas sp. was greatest at 150µL(In 2021, Jembulingam Sabarathinam).

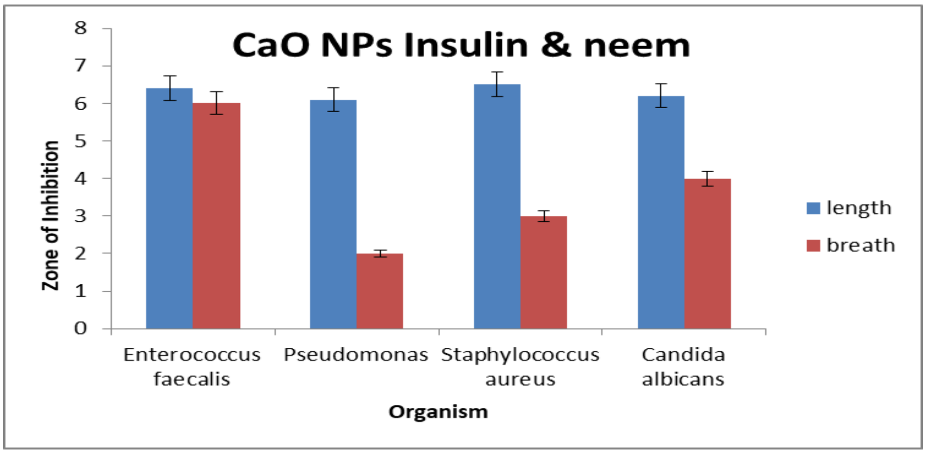


Figure11: The bar graph depicts the measurement of the zone of inhibition of *Azadirachta indica* and *Chamaecostus cuspidatus* formulation-mediated calcium oxide nanoparticle-coated silk sutures; the Y axis represents the measurement of the zone of inhibition; the X axis denotes the specific organisms

Antioxidant activity;

Figures 12 demonstrates the enhanced concentration of antioxidant activity in the produced CaO nanoparticles. The earlier research demonstrates that CaO nanoparticles have strong antioxidant action. The antioxidant activity of the CaO nanoparticles produced utilising *Azadirachta indica* and *Chamaecostus cuspidatus* is thus established. The use of nanoparticles for antioxidant activity in nowadays modern biomedical applications is very common. The antioxidant potential of S. anacardium, G. lanceolarium, and B. retusa established that the green synthesis of silver nanoparticles is extremely safe for biomedical applications, which also correlates with the same finding supported by another study. 2020 (Yugal Kishore Mohanta)

Figure 12 Bar graph depicts the antioxidant activity of *Azadirachta indica and Chamaecostus cuspidatus* formulation mediated calcium oxide nanoparticle coated silk sutures; Y axis represent the percentage of inhibition; X axis denotes the concentration.

Anti inflammatory activity:

Figure 13 shows that the fabricated CaO nanoparticles exhibit similar anti-inflammatory activity to that of the chemical analgesic diclofenac sodium at a concentration of 50 mL. The earlier study demonstrates that CaO nanoparticles have effective anti-inflammatory activity. This proves that the CaO nanoparticles made from *Chamaecostus cuspidatus* and *Azadirachta indica* also have anti-inflammatory properties.

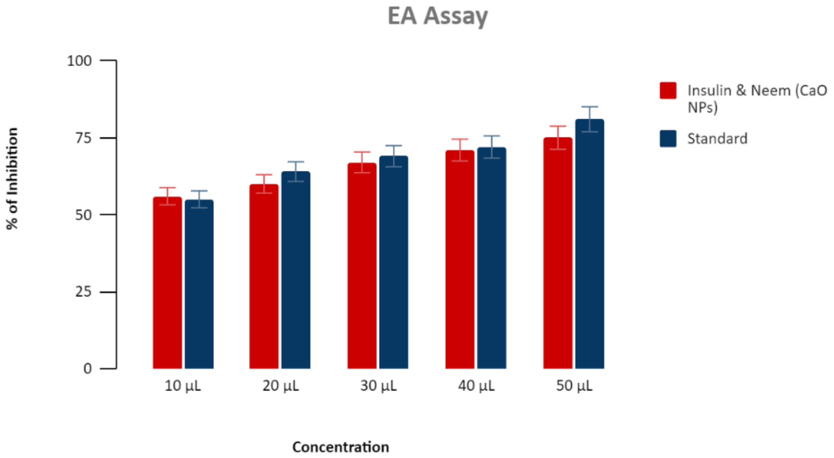


Figure 13: The bar graph depicts the anti-inflammatory activity of *Azadirachta indica* and *Chamaecostus cuspidatus* formulation-mediated calcium oxide nanoparticle-coated silk sutures; the Y axis represents the percentage of inhibition; X-axis denotes the concentration.

Embryonic toxicology :

The rate at which fertilised eggs are in a medium containing CaO hatch is shown in Figure 14. Higher concentrations of 80µL showed a hatching rate of 40–45% while 5µL showed a hatching rate of 80–85%, showing embryonic hatchability. The hatching rate was marginally lower but still greater than 70% in concentrations of 10 and 20µL. The hatching rate was lowered to 60% even at a 40µL hatching rate. A graphic representation of the viability of zebrafish eggs is shown in Figure 15. The viability was shown to be higher than 60% at all concentrations. The viability of the embryos was 80% at 10µL concentration. The viability was reduced to less than 65% at the highest concentration measured at 80µL.In Figures 13, stereomicroscope images taken at regular intervals show the development of embryos in the control and calcium oxide nanoparticle groups. In the various developmental stages, no malformations were seen. This demonstrated that the CaO nanoparticle present in the test sample had no negative effects on the zebrafish embryo's development. Zebrafish embryos were exposed to CaO NPs at a low dose (1 mg/L), but there were no appreciable developmental abnormalities as a result.

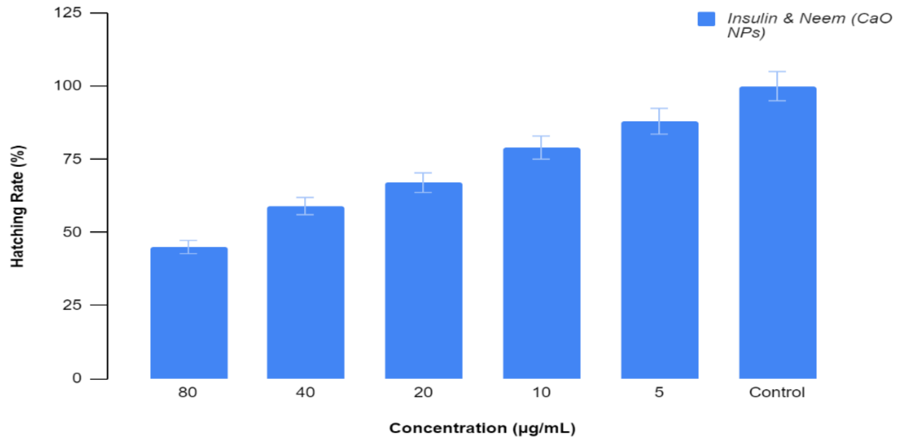


Figure 14: Bar graph depicts the hatching rate of *Azadirachta indica* and *Chamaecostus cuspidatus* formulation-mediated calcium oxide nanoparticle-coated silk sutures; the Y axis represents the Hatching rate; the X axis denotes the concentration.

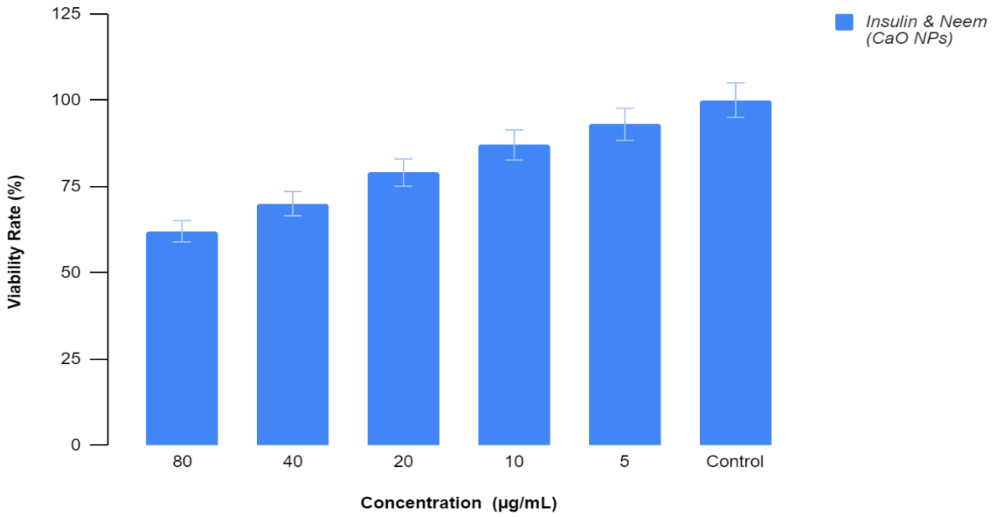


Figure 15: Bar graph depicts the hatching rate of *Azadirachta indica* and *Chamaecostus cuspidatus* formulation-mediated calcium oxide nanoparticle-coated silk sutures; the Y axis represents the viability rate; the X axis denotes the concentration.n.

4. DISCUSSION

Since bacteria adhere to the suture material used during oral and periodontal surgical treatments, foreign suture materials are a cause of infection. Sutures are always placed in high vascular supply regions to aid healing, which is also a moist environment that fosters the growth of bacteria. Since bacteria are retained in the interstices when natural, multi-braided sutures like silk are used, the chance of infection increases. As a result, the sort of suture used is a key consideration when determining the degree of infection risk. Due to the allergic reaction they can induce, the use of animal intestine-based monofilament sutures is now prohibited in Japan and Europe. On the other side, natural fibre silk sutures absorb more water and encourage bacterial colonization. Surgeons prefer to use synthetic sutures because they do not encourage the development of bacterial colonies on their surface, even though both natural sutures have excellent biocompatibility, less tissue reaction, and better flexibility. We think using silk sutures coated with nanoparticles can lessen the colonization of pathogenic organisms. In our current study, a calcium oxide nanoparticle with *Azadirachta indica* and *Chamaecostus cuspidatus* plant extract was chosen as a non-toxic, safe inorganic antibacterial agent. Additionally, it has been noted that calcium oxide nanoparticles prevent bacterial growth.

Calcium oxide nanoparticles have been shown to have antimicrobial, anti-inflammatory, and pro-regenerative properties. By releasing these nanoparticles into the wound site, the coated sutures may help to prevent infection, reduce inflammation, and promote tissue healing.

A key element in the area of nanotechnology is the creation of environmentally friendly methods for synthesizing nanoparticles. The environmentally and economically stable technique that can be made by the green synthesis of nanoparticles using eco-friendly materials can also benefit from the combined efforts of herbs like Chamaecostus cuspidatus and Azadirachta indica. (Rai and Biswas, 2019)These herbs have reportedly been shown to have antimicrobial, antioxidant, cytotoxic, and anti-inflammatory qualities. Significantly many of these plants' ingredients have been used to create nanoparticles.Suture techniques, flap design, and treatment planning are critical surgical elements that may influence the success of dental and craniofacial implant procedures(Nagendrababu *et al.*, 2023; Rexlin *et al.*, 2023; Vedha Vivigdha *et al.*, 2024).

According to research done by Jembulingam Sabarathinam in 2021, the antimicrobial properties of the silver nanoparticles produced by using the herb *Solanum nigrum* and *Indigofera tinctoria* as a reducing agent can be coated on sutures to lessen the bacterial load on the surgical site after the procedure. Although the embryonic toxicology of silver nanoparticles and its herb availability were not mentioned in the previous research. *Azadirachta indica* and *Chamaecostus cuspidatus*, two widely accessible herbs, were used in our most recent research, which was carried out in soil from India. The anti-inflammatory and cytotoxic properties of calcium nanoparticles developed using green chemistry have also been proven in our recent research, supporting their use in oral surgery.

From this point forward, we contemplate the use of suture material coated with *Azadirachta indica* and *Chamaecostus cuspidatus* formulated calcium oxide nanoparticles as an alternative to conventional suture materials for diabetic patients having oral surgery. For the time being, diabetic patients' wounds have been closed with traditional stitching materials . The healing process in an operated location can be sped up by using this alternative suture material. To market the product in the present environment, additional in vivo studies must be conducted in the future.

5. CONCLUSION

To attain the aseptic field, which is regarded as the most crucial tenet of oral surgery and oral surgical procedure, it is imperative to implement all available tools. The new calcium oxide nanoparticle that is presented here may be effective against resistant bacteria and may accelerate the healing of wounds at surgical sites. To coat the surgical silk sutures material, the innovative calcium oxide nanoparticles that were created with the aid of plant extracts like *Azadirachta indica* and *Chamaecostus cuspidatus* proved to be the most effective wound healing agent. Important anti-bacterial properties against *Enterococcus faecalis*, *Pseudomonas sp.*, and *Staphylococcus aureus* were acquired by the formed nanoparticles. Additionally, they exhibit anti-inflammatory properties, lesser cytotoxicity and demonstrate biocompatibility. This development in surgical biomaterials may aid in reducing the toxic effects of pathogenic organisms and promoting healing at the site of surgery while demonstrating an environmentally friendly material that is economically effective as well but also proves to be a material with minimal risk to people and the environment.

REFERENCES

[1] Bhalerao, A. *et al.* (2023) ‘Dynamic navigation for zygomatic implant placement: A randomized clinical study comparing the flapless versus the conventional approach’, *Journal of dentistry*, 130, p. 104436.

[2] Bonanthaya, K. *et al.* (2021) *Oral and Maxillofacial Surgery for the Clinician*. Springer Nature.

[3] Burnier, M. (2023) ‘The role of adherence in patients with chronic diseases’, *European journal of internal medicine* [Preprint]. Available at: https://doi.org/10.1016/j.ejim.2023.07.008.

[4] Chan, H.-L. (albert) and Velasquez-Plata, D. (2022) *Microsurgery in Periodontal and Implant Dentistry: Concepts and Applications*. Springer Nature.

[5] Draznin, B. (2016) *Managing Diabetes and Hyperglycemia in the Hospital Setting: A Clinician’s Guide*. American Diabetes Association.

[6] Felicita, A.S. and Khader, S.A. (2024) ‘Comparison of two treatment protocols for intrusion and retraction of maxillary anterior teeth using mini-implants : A prospective clinical trial’, *Journal of orofacial orthopedics = Fortschritte der Kieferorthopadie: Organ/official journal Deutsche Gesellschaft fur Kieferorthopadie*, 85(1), pp. 13–29.

[7] Gulati, K. (2023) *Surface Modification of Titanium Dental Implants*. Springer Nature.

[8] He, Y. *et al.* (2023) ‘Hypoglycemic Coma Caused by Methimazole-Induced Insulin Autoimmune Syndrome, a Case Study’, *Diabetes, metabolic syndrome and obesity: targets and therapy*, 16, pp. 1149–1154.

[9] Katiyar, P. (2021) *CLINICAL STUDIES ON THE ROLE OF PREPARATIONS OF KASNI SEEDS IN TYPE 2 DIABETES MELLITUS PATIENTS*. Horizon Books (A Division of Ignited Minds Edutech P Ltd).

[10] Khan, A.U. *et al.* (2023) ‘Antibacterial and Antibiofilm Activity of -Mediated Calcium Oxide (CaONPs) Phyto-Nanoparticles’, *Molecules* , 28(14). Available at: https://doi.org/10.3390/molecules28145553.

[11] Koul, O. and Wahab, S. (2007) *Neem: Today and in the New Millennium*. Springer Science & Business Media.

[12] Kumar, S., Mulchandani, V. and Das Sarma, J. (2022) ‘Methanolic neem (Azadirachta indica) stem bark extract induces cell cycle arrest, apoptosis and inhibits the migration of cervical cancer cells in vitro’, *BMC complementary medicine and therapies*, 22(1), p. 239.

[13] Lakshmi, T. *et al.* (2015) ‘Azadirachta indica: A herbal panacea in dentistry - An update’, *Pharmacognosy reviews*, 9(17), pp. 41–44.

[14] Nagendrababu, V. *et al.* (2023) ‘Dental patient-reported outcomes following traumatic dental injuries and treatment: A narrative review’, *Dental traumatology: official publication of International Association for Dental Traumatology*, 39(4), pp. 304–313.

[15] Oguntibeju, O. (2014) *Antioxidant-Antidiabetic Agents and Human Health*. BoD – Books on Demand.

[16] Percival, S. and Cutting, K. (2010) *Microbiology of Wounds*. CRC Press.

[17] Ponnanikajamideen, M. *et al.* (2019) ‘In Vivo Type 2 Diabetes and Wound-Healing Effects of Antioxidant Gold Nanoparticles Synthesized Using the Insulin Plant Chamaecostus cuspidatus in Albino Rats’, *Canadian journal of diabetes*, 43(2), pp. 82–89.e6.

[18] Prasad, A.S. and Sivakumar, A. (2022) ‘ATM technique - a novel radiographic technique to assess the position of buccal shelf implants’, *Dento maxillo facial radiology*, 51(5), p. 20210346.

[19] Puri, H.S. (1999) *Neem: The Divine Tree Azadirachta indica*. CRC Press.

[20] Rai, M. and Biswas, J.K. (2019) *Nanomaterials: Ecotoxicity, Safety, and Public Perception*. Springer.

[21] Rao, C.N.R., Müller, A. and Cheetham, A.K. (2006) *The Chemistry of Nanomaterials: Synthesis, Properties and Applications*. John Wiley & Sons.

[22] Rexlin, P.E.J. *et al.* (2023) 'CHARACTERISATION OF RESORBABLE AND NON- RESORBABLE SUTURES COATED WITH Punica granatum SEED EXTRACT: AN in vitro PILOT STUDY', *The journal of evidence-based dental practice*, p. 101952.

[23] Sreenivasagan, S., Subramanian, A.K. and Chae, J.M. (2023) 'Comparison of treatment effects during en-masse retraction of upper anterior teeth placed using mini-implants placed at infrazygomatic crest and interradicular sites: A randomized controlled trial', *Orthodontics & craniofacial research* [Preprint]. Available at: https://doi.org/10.1111/ocr.12679.

[24] Thomas, S. *et al.* (2022) *Advanced Technologies and Polymer Materials for Surgical Sutures*. Woodhead Publishing.

[25] Tyler, J. (2020) *Insulin Plant for Diabetes: The Wonder Medicinal Plant that Cures Diabetes*.

[26] Vedha Vivigdha, A. *et al.* (2024) 'Effectiveness of promethazine on preoperative and intraoperative sequelae in cleft palate surgeries', *Orthodontics & craniofacial research* [Preprint]. Available at: https://doi.org/10.1111/ocr.12743.