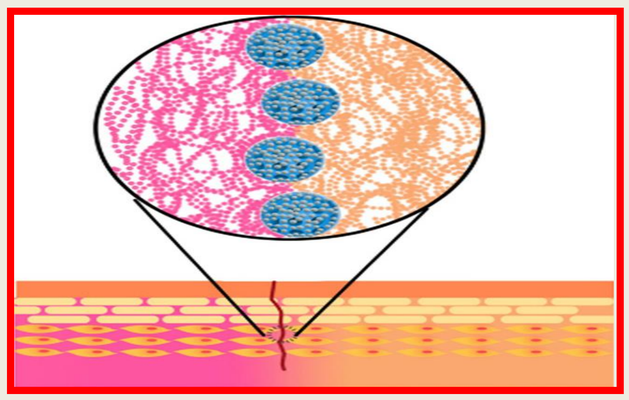
Design and Development of Curcumin Loaded Zinc Oxide Nanoparticles Decorated Mesoporous Silica Liquid Stitches: A Proof of Concept in Animals

Introduction:

The new era is exploring the Mesoporous silica nanoparticles for the efficacy of Tissue gluing and wound healing. It is proved that Mesoporous silica has been safe and efficacious to be used in Drug delivery. It has obtained the USFDA GRAS status as it is biocompatible and biodegradable in nature. The mesoporous Silica has honey comb like structure and hence it has ability to acquire drug molecules into it. The entire Phenomenon of the tissue glue is based on the Nanobridging effect. The numerous protein chains present in the body tissues are adsorbed by the Nanoparticles and a connective bridge is created in between them . This bridge facilitates the gluing and healing of the wound.



Objectives:

- Synthesize Mesoporous Silica nanocomposites
- Surface adsorption of Zinc oxide Nanoparticles & curcumin loading in MSNs
- To offer wound/ surgical incision closure formulation alternative for stitches and Staples.
- Evaluation wound closure & recovery ability of formulation

Materials:

The materials used were TEOS, Pluronic F127, HCl, Zinc Nitrate hexahydrate, APTES, Curcumin etc

Method:

Step 1: Synthesis of Mesoporous Silica Nanoparticles (Sol-Gel reaction)

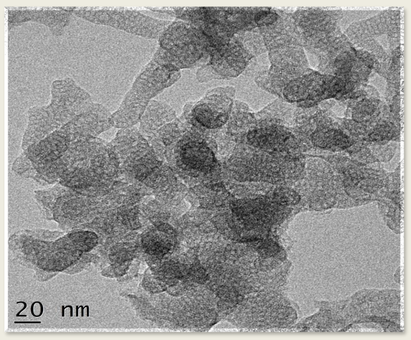
Step 2 : Amine Functionalization

Step 3 : Loading of Zinc Oxide Nanoparticles

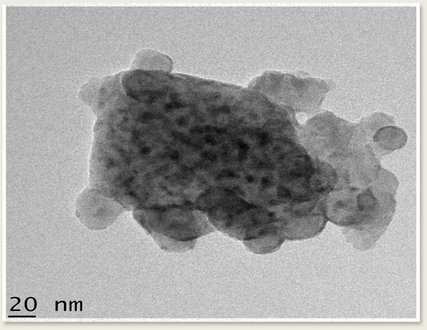
Step 4 : Drug Loading by wetness impregnation method

Results

1. TEM images



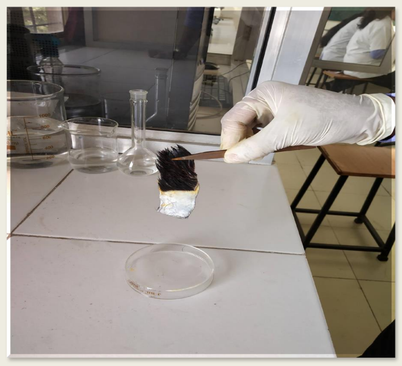
Plain MSN



Drug & Nanoparticles loaded MSNs

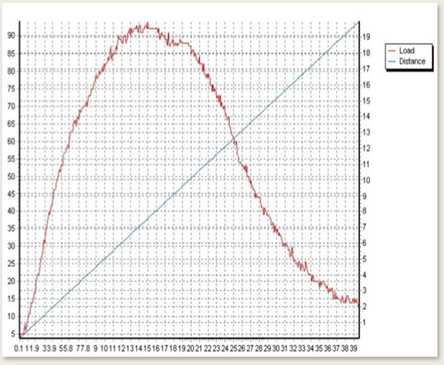
2. Shear Lap Adhesion Test :

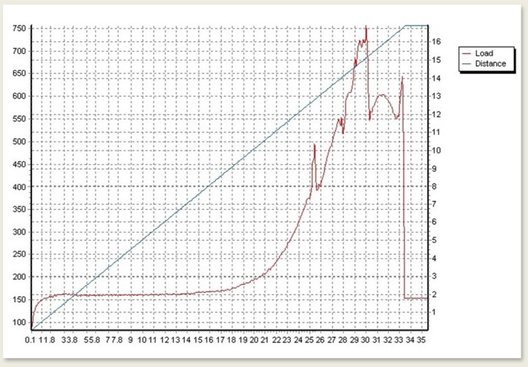
MSN



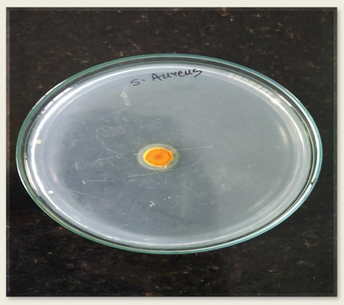
Drug & Nanoparticles loaded MSNs

Determination of Glue Strength using CT3 Texture Analyzer





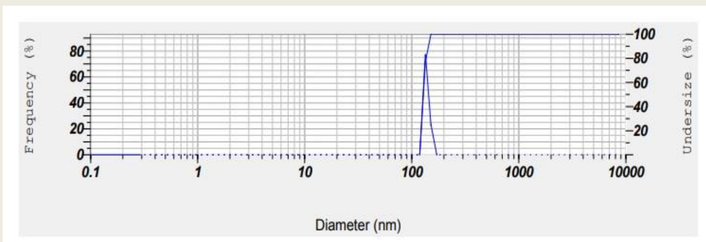
3.Antibacterial Assay:



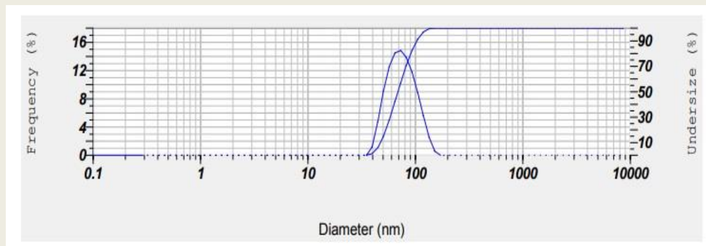
S. aureus

P. aeruginosa

4. Particle Size



Plain MSNs (127 nm)



Composite (79 nm)

5.Animal Study: (CPCSEA/IAEC/2019-20/07)

B. Wound Healing a) Tissue Glue

Day 0

Day 1

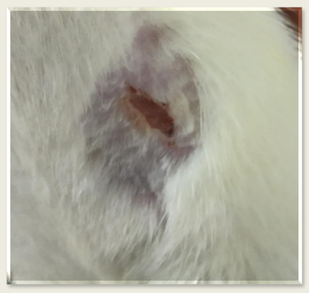
Day 3

Day 5

b) Suture

Day 1

Day 3



Day 5

Conclusion:

The Mesoporous silica nanoparticles based tissue glue has effectively glued the skin in ***ex-vivo & in-vivo model.*** Morever it had shown an excellent antibacterial activity against skin pathogen. The in-vivo gluing in 30 seconds & healing of rats in 5 days was significant as compared to the suture positive control which healed in 9 days.

Achievements for Research & Commercialization

1. Received Second Prize at Avishkar & fellowship of Rs 30,000 from University, Association of India.
2. Shortlisted by **CRPF, India**
3. Shortlisted by **SUPRA**
4. Selected for **Commercialization** by Research Park Foundation, SPPU, Pune. India

References:

Gao Y, Han Y, Cui M, Tey HL, Wang L, Xu C. ZnO nanoparticles as an antimicrobial tissue adhesive for skin wound closure. J Mater Chem B. 2017;5(23):4535–4541