Drug Releasing Antibacterial Scaffold for Tissue Engineering and Drug Delivery Application

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ABSTRACT SUMMARY
Curcumin, a natural polyphenol, is widely used in the Indian traditional medical system in treating various diseases. It is an effective antibacterial and wound healing agent. In this present work, a novel curcumin releasing chitosan scaffold was designed to provide antibacterial and wound healing effect at the site of injury. This dual purpose scaffold can be used as a drug delivery carrier to protect the wounds from possible microbial infections and as a tissue engineering scaffold to accelerate the wound healing process in chronic and severe wound cases. The drug releasing scaffold was fabricated and evaluated for swelling index and in-vitro drug release profile. The morphology of the scaffold was studied by scanning electron microscope. The antibacterial activity of the fabricated scaffold was effective against Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa. The suitability of the scaffold for tissue engineering application was studied using Vero cell as a representative of mammalian cells. MTT assay showed that there was a significant cell growth in cell seeded scaffold than the control. These results indicate that the dual purpose scaffold could be used as both drug delivery system and as an artificial biodegradable membrane for tissue regeneration.

INTRODUCTION
Wound healing is a complex process affected by various factors. The main factor affects the wound healing process is the microbial infections at the injured site. Sometimes, these microbial infections may lead to critical conditions to the host. Therefore, chronic and severe wounds require special attention from these microbial infections to treat the condition effectively. Curcumin, a natural polyphenol obtained from turmeric is an effective antimicrobial and wound healing agent. Chitosan is a natural polymer and it can be used effectively in the fabrication of scaffolds because of its low cost, low toxicity, biodegradability, and biocompatibility. Biodegradable scaffolds are useful in tissue replacements or in tissue regeneration. However, these biodegradable scaffolds also can be used as a vehicle for delivering the drugs. In this present work, a novel drug releasing scaffold was developed in order to be used as a drug delivery vehicle and tissue engineering scaffold for effective wound healing.

EXPERIMENTAL METHODS
Chitosan scaffold was prepared by freeze drying method followed by stabilization. To the prepared scaffold, curcumin in ethanol was added and air dried at room temperature. The scaffold was evaluated for swelling index and in-vitro curcumin release profile. In-vitro dissolution samples were periodically withdrawn and analysed by HPLC using a C₁₈ column at 424 nm. The cross sectional morphology of the curcumin releasing scaffold was studied using ZEISS scanning electron microscope (ZEISS, EVO 18). The antibacterial activity of the curcumin releasing scaffold was tested against S. aureus, E. coli and P. aeruginosa by agar diffusion method. To check the suitability of the scaffold for tissue engineering, the scaffold was seeded with Vero cells. 0.5 ml of DMEM medium with 10% serum was added to the scaffold and incubated for 48 h in a CO₂ incubator (37 °C, 5% CO₂ and 95% humidity). After incubation the scaffold was transferred aseptically into a new sterile cell.
culture dish and MTT assay was carried out to determine the viability of cells.

RESULTS AND DISCUSSION

The chitosan scaffold was fabricated by freeze drying method followed by stabilization. The SEM image (Figure 1) of the fabricated scaffold showed interconnected pores throughout its structure and it was able to hydrate and release the drug in the dissolution medium.

Figure 1. Cross sectional SEM image of the curcumin releasing chitosan scaffold

The antibacterial property (Figure 2) of the curcumin releasing scaffold was effective against the tested microorganisms.

Figure 2. Antimicrobial property of the curcumin releasing chitosan scaffold. a) Plain and curcumin releasing scaffold in the medium b) Zone of inhibition observed after removal of the scaffolds from the medium (test organism *E. coli*)

The MTT assay (Figure 3) showed that there was a significant increase in the cell growth.

Figure 3. MTT assay results of the curcumin releasing scaffold a) Cell viability in the curcumin releasing scaffold b) Control

CONCLUSION

The curcumin releasing chitosan scaffold was fabricated and it was evaluated for suitability as a drug delivery vehicle and tissue engineering scaffold. The antibacterial property of the curcumin releasing chitosan scaffold will protect the wounds from the possible microbial infections. The viability and proliferation of cells within the scaffold show that the scaffold could be used in tissue regeneration. This study shows that the scaffold could play a dual role by acting as a drug delivery carrier and as a tissue engineering scaffold for cell attachment and proliferation. This property could be utilized in treating wounds, especially those involving sepsis, which requires continuous application of drug and generation of new tissue.

REFERENCES


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