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PREPARATION AND CHARACTERISATION OF ALGINATE BASED COMPOSITE BIOINK FOR BONE TISSUE ENGINEERING APPLICATIONS

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ABSTRACT:
INTRODUCTION: Three dimensional (3D) printing,a revolutionary approach of regenerating the defective tissue or organ using tissue engineering principles with the help of a component called bioink developed using the naturally available polysaccharides such as alginate has led to the successful regeneration of the bony defect in the field of periodontics.The current study aims at analyzing the compression stability,Surface properties via SEM analysis,biocompatibility and swelling/degenerative capacity of alginate based composite bioink and also aims at fabricating a successful 3D tissue for repair using the same component. **MATERIALS AND METHOD:** In the current study Alginate Methacrylate (AlgMA) was synthesized using methacrylic anhydride as described by Chou et al and 3D printing ink was fabricated by preparing a homogeneous solution of Resin and PEGDA in ratio 1:1. **RESULTS:** The Alginate Methacrylate HAP Incorporated Bioink has shown good mechanical structural integrity conductive for cell adhesion,differentiation and proliferation.It is also Biocompatible and shows good cell viability. **CONCLUSION:** The Novel Alginate Based Composite Bioink developed in the current study has shown good potential properties required for periodontal regeneration of the bony defect using bone tissue engineering applications.

KEYWORDS: 3D BIOPRINTING, TISSUE ENGINEERING PRINCIPLE, ALGINATE BASED COMPOSITE BIOINK

INTRODUCTION:

Periodontitis is defined as an inflammatory disease of the supporting tissue of the teeth which is caused by a specific or group of microorganisms resulting in progressive destruction of the periodontal ligament fibers and alveolar bone with increased probing depth formation,recession or a combination of both(1). Periodontitis leads to various changes in the bone which are crucial because they result in destruction of bone which ultimately leads to tooth loss(2). Destruction of bone forms various defects such as osseous defects,one wall vertical defect,circumferential vertical defect,combined osseous defect,osseous craters. bulbous bone contours,reversed architectural defects and finally ledge(3).

Three dimensional (3D) printing,a revolutionary approach of regenerating the defective tissue or organ using tissue engineering principles with the help of a component called bioink developed using the naturally available polysaccharides such as alginate has led to the successful regeneration of the bony defect in the field of periodontics.(4,5)3D printing is basically an additive layering technology which focuses on successful fabrication of 3D tissues through layer by layer extrusion method(5–8).Bioink are those materials which are biocompatible and can be used in the process of fabrication intoxic 3D tissue for regeneration(9).Bioink are basically physical scaffold to which cell adheres and proliferate successfully to form a tissue construct (9,10)Bioinks also incorporate naturally existing hydrogels in the process of fabricating a scaffold for 3D printing(5,6).

In the Recent years many scientists across the world are working with interest in generating a successful bioink with good physical,mechanical,rheological properties and with good biodegradability and biocompatibility that can be incorporated in the process of fabricating 3D tissue using the process 3D printing (11,12)The current study aims at analyzing the compression stability,Surface properties via SEM analysis,biocompatibility and swelling/degenerative capacity of alginate based composite bioink and also aims at fabricating a successful 3D tissue for repair using the same component.

MATERIALS AND METHOD:

SYNTHESIS OF ALGINATE METHACRYLATE (AlgMA): AlgMA was synthesized using methacrylic anhydride as described by Chou et al. 1% of alginate solution was prepared in deionized water and the pH was adjusted to 8 by using 5N NaOH. 20 fold excess of methacrylic anhydride was added to the alginate solution and stirred overnight at 4 ºC. The pH was periodically adjusted to 8 using 5N NaOH. The product was lyophilized and stored at 4 ºC for further use.

PREPARATION OF 3D PRINTING INK

The 3D printing ink was fabricated by preparing a homogeneous solution of Resin and PEGDA in ratio 1:1. 50mg of Hydroxyapatite (HAP) and collagen was added to the prepared solution.0.5% camphorquinone photoinitiator was added to the ink.

RESULTS AND DISCUSSION:

Fig1: SEM ANALYSIS

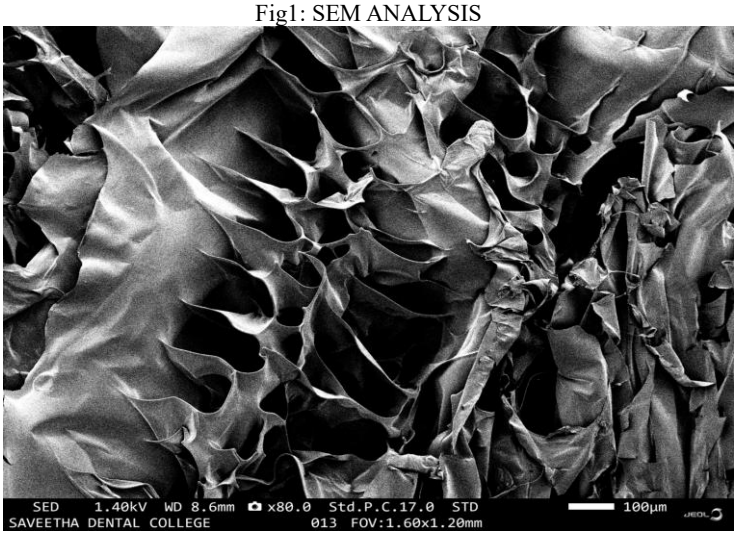

Fig 2: CELL VIABILITY

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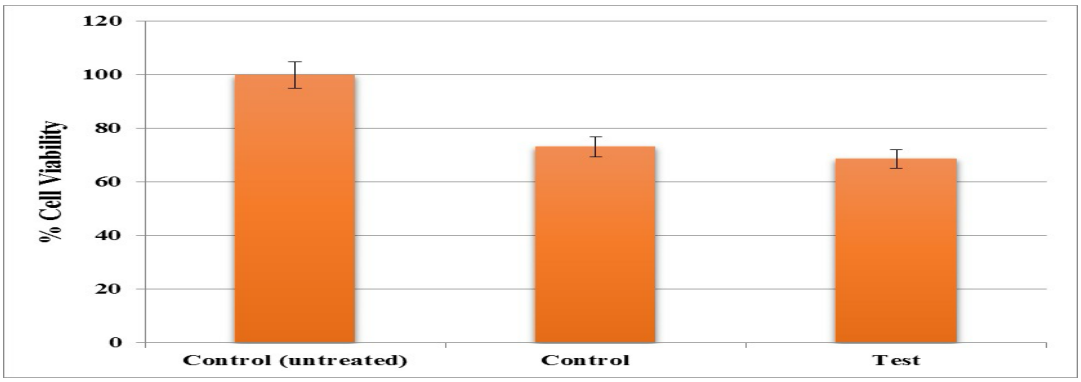


Fig 3: SWELLING/DEGENERATION

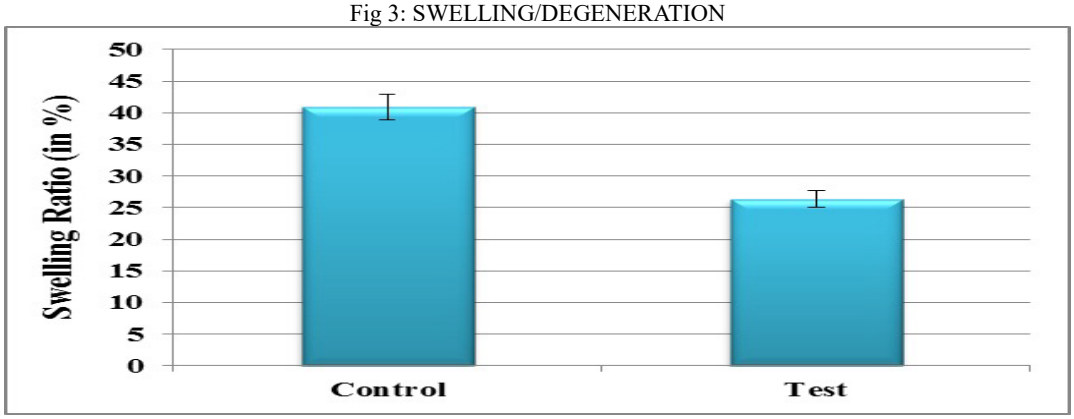
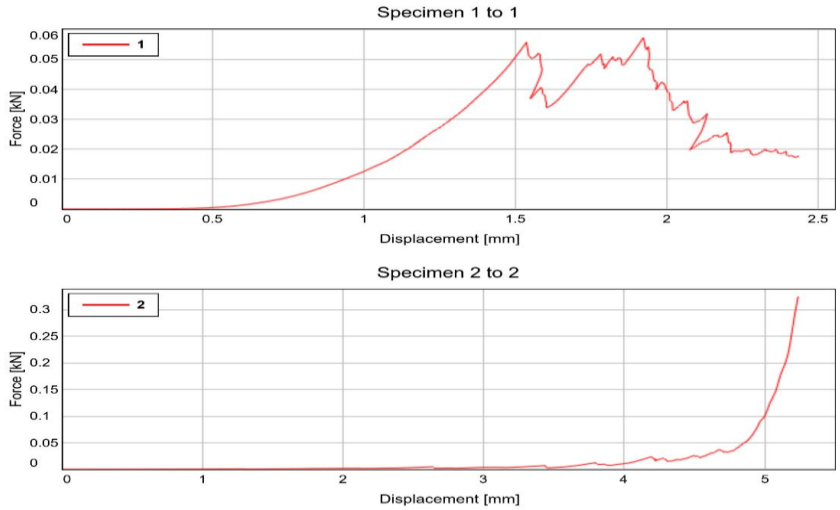


Fig 4: COMPRESSION STABILITY



This study illustrates that the alginate based composite bioink that has been formulated demonstrates excellent surface properties that are crucial for cell attachment, differentiation, and proliferation(Figure 1) .As depicted in Figure 2, the current study found that the Alginate based composite bioinks were capable of exhibiting good cell viability in comparison with the controls and the untreated groups. It has been shown in figure 3 of the study that the alginate-based composite bioink that has been formulated in this study has not shown either drastic swelling or degeneration, which is a reliable indication that this alginate-based composite bioink can be used to print 3D structures as a bioink(13–15). According to FIG 4, the composite bioink formulated on the basis of alginate possesses optimum compression stability, thus presenting a potential for use as a bioink for 3D printing applications(16,17).

Previous study conducted by Lakshmi T. Somasekharan was successful in developing ADA-gelatin-PRP based bioink for 3D bioprinting and was was also able to fabricate a 3D tissue (18).The results of the previous study had a good cell viability compared to its control group,when compared the current Alginate based composite bioink also depicted a similar kind of results with respect to the cell viability.This evidence stands as a proof stating that 3D tissue regeneration using this bioink is safe and reliable(19,20).

3D bioprinting of the bony defect with the help of a naturally synthesized bioink stands as a reliable source in the current situation leading to the achievement of complete periodontal regeneration using the tissue engineering principle (21,22).The current study stands as an option and evidence to reliably consider regeneration using 3D printing in the future.

CONCLUSION:

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The current study within the limitations present concludes that the novel Alginate Based Bioink developed in the present study has shown good potential for periodontal regenerative and bone tissue engineering applications.Further more in-vitro and in-vivo studies must be carried to analyze the rheological properties,printing optimization of this alginate based composite bioink.

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AUTHOR CONTRIBUTION:
Ms. Srivarsha Ranjeet: Literature search, survey, data collection, analysis, manuscript writing. Dr. Dinesh Kumar: Study design, data verification, manuscript, drafting, manuscript correcting.

CONFLICT OF INTEREST:
The authors declare that there are no conflicts of interest in the present study.

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