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Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA

Bioactive implants for bone regeneration and prevention of infections

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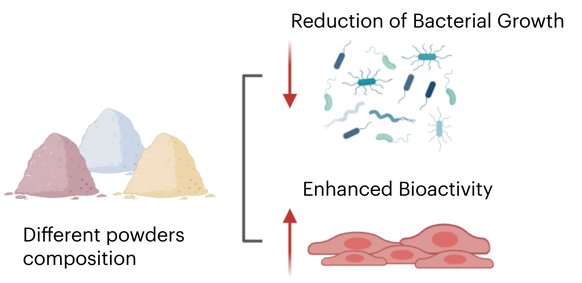
INTRODUCTION

Bone is a highly specialized tissue with essential physiological functions; however, diseases, trauma, or tumors can exceed its natural regenerative capacity. To mimic the bone structure, three-dimensional composite scaffolds were developed and characterized by combining alginate with bioactive glass, respectively the organic and the inorganic construct phases. Different bioactive glass compositions were investigated to identify the most suitable ionic formulation capable of conferring both bioactive and antibacterial properties. The scaffolds here developed offer a powerful tool for bone regeneration (i) mimicking the native extracellular matrix (ECM), (ii) providing a supportive three-dimensional bioactive microenvironment for cells proliferation and function as antimicrobial agent in the early regenerative stages.

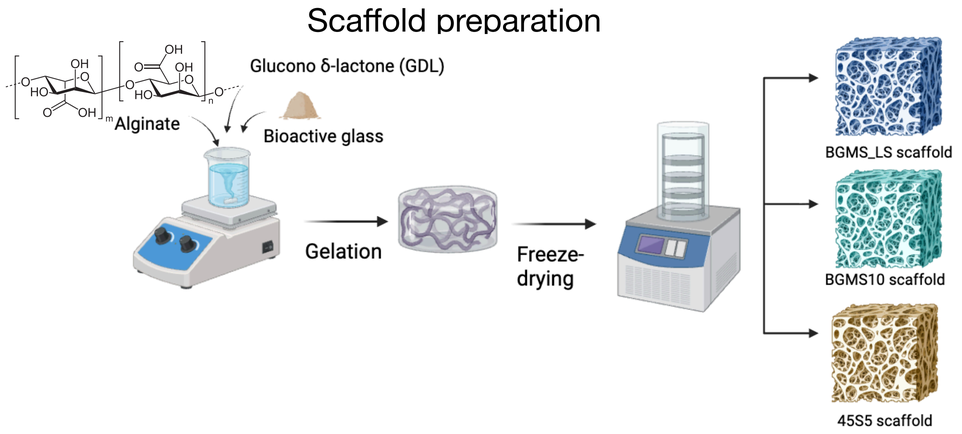
AIM

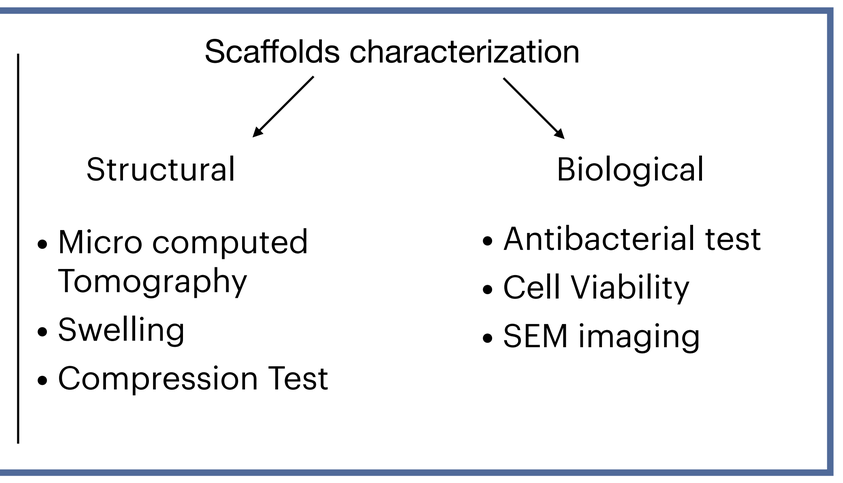
Development and evaluation of novel composite scaffolds for bone regeneration, focusing on enhanced osteogenic differentiation and antibacterial properties.

MATERIALS AND METHODS



The powders were tested to evaluate their antibacterial and bioactive properties.



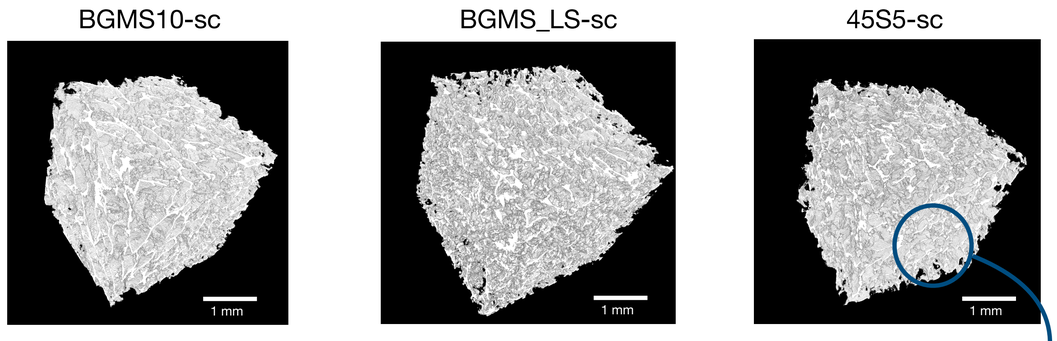


MATERIAL CHARACTERIZATION

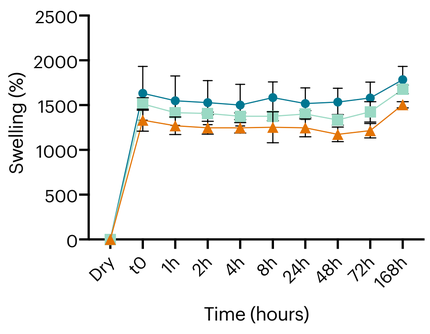
μCT ANALYSIS

Samples	Porosity	Tb. Th. (μm)	Tb. Sp. (μm)	Conn. D (μm^{-3})
BGMS_LS-sc	90 ± 0.0005	39.92 ± 0.5	236.57 ± 11.85	$1.46 \times 10^{-7} \pm 1.27 \times 10^{-8}$
BGMS10-sc	90 ± 0.027	39.96 ± 0.75	240.09 ± 64.63	$1.96 \times 10^{-7} \pm 2.13 \times 10^{-7}$
45S5-sc	90 ± 0.011	37.57 ± 0.35	191.78 ± 1.48	$1.86 \times 10^{-7} \pm 1.41 \times 10^{-7}$

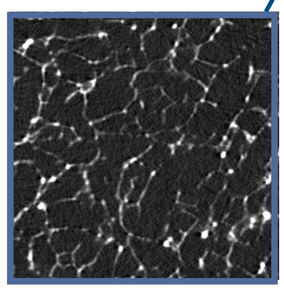
*Tb. Th (trabecular thickness), Tb. Sp (trabecular space), Conn D. (Connectivity Density).



SWELLING

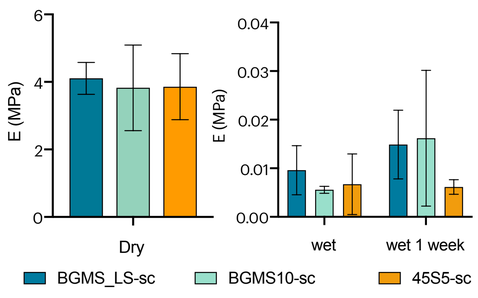


The swelling behavior showed high stability, with minimal variation over time.



μCT slice

COMPRESSION TEST



Elastic Modulus (MPa)

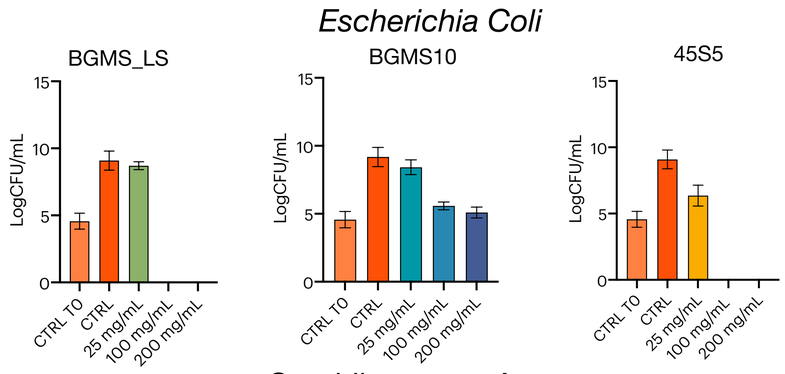
	Dry	Wet	1 week
BGMS_LS	4.10 ± 0.47	0.009 ± 0.0050	0.014 ± 0.007
BGMS10	3.2 ± 1.26	0.005 ± 0.0007	0.006 ± 0.0014
45S5	3.85 ± 0.97	0.009 ± 0.0062	0.006 ± 0.013

There are no significant differences among the three composition in terms of mechanical properties.

*The high S.D. is related to the inhomogeneous porosity of the samples

BIOLOGICAL CHARACTERIZATION

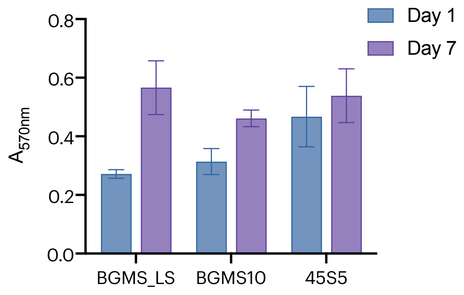
POWDERS ANTIBACTERIAL PROPERTIES



LS powder showed antibacterial activity with E. Coli., while BGMS10 formulations showing bacteriostatic effects against both Gram-positive and Gram-negative bacteria.

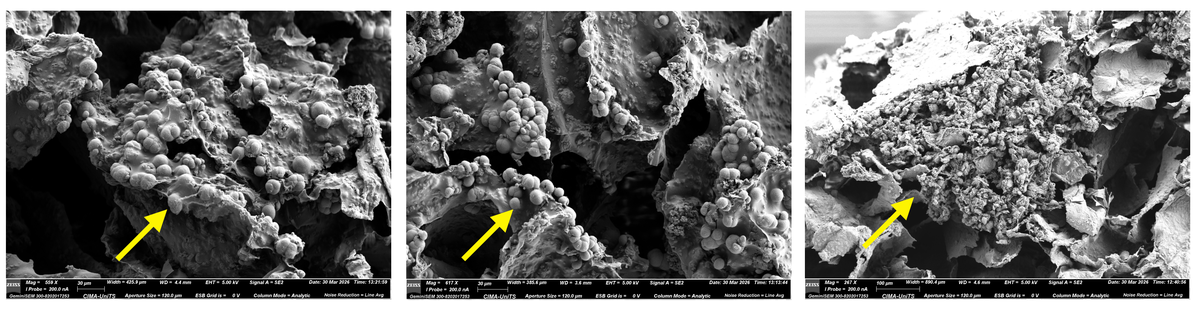
These powders will be incorporated into alginate-based scaffolds to enhance their overall biological performance.

VIABILITY ON SCAFFOLD



All scaffold compositions showed good cell adhesion and supported cell viability over time.

SEM analysis revealed the presence of cell clusters on the surface.



*Yellow arrows indicate cells clusters

CONCLUSION

Due to the porous nature of the scaffold and relatively weak mechanical properties related to the polymer, these structures are promising for small defects and applications subjected to limited mechanical loads, effectively combining antibacterial properties and osteoinductive features.

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