Development, characterization and in vitro analysis of the 3D hydrogel drug delivery system

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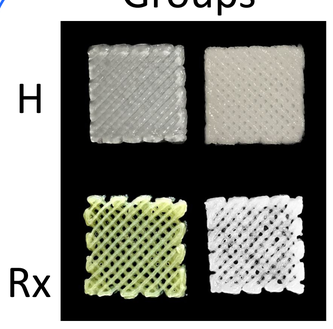
INTRODUCTION

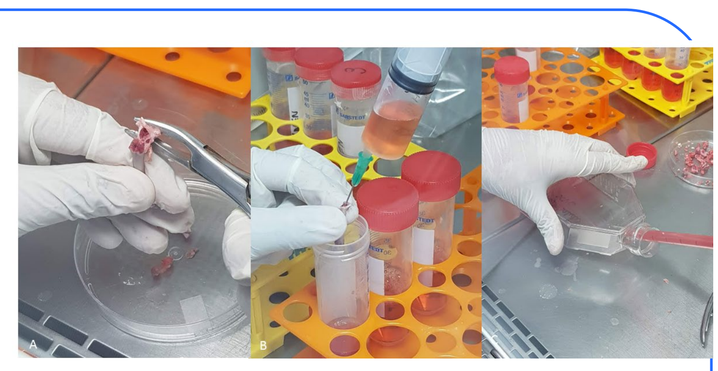
Medications such as raloxifene and strontium ranelate have proven clinical efficacy for osteoporosis but also have side effects. In order to avoid these adverse effects, this study proposes the use of hydrogel incorporated with bioglass functionalized with drugs that will be applied locally in the bone tissue. Drug delivery systems can be associated with polymeric or hydrogel matrices which can be combined with active particles that will make the system more functional. In this context, bioglasses appear as an option to optimize the hydrogel drug delivery, since it is capable of inducing the adhesion and proliferation of osteogenic cells to the site of the bone defect (Rizwan et al., 2017).

Groups and Cells isolation

Groups



H- hydrogel
B- H+bioglass
Rx- H+B+Rx
Sr- H+B+Sr



Cells isolated from femurs of ovariectomized rats

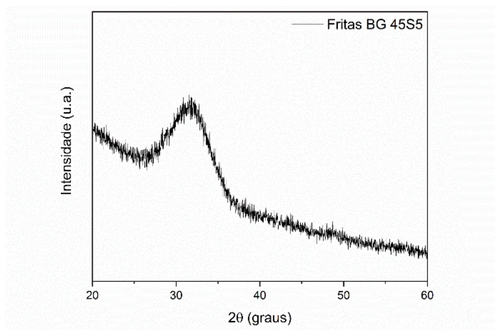
METHODS & MATERIAL

Synthesis of Bioactive Glass BG 45S5

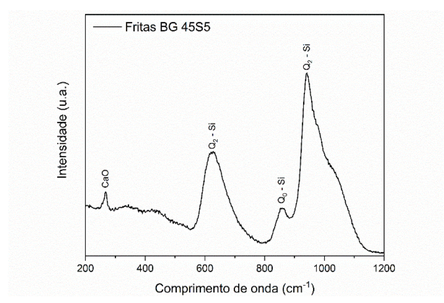
Glass composition: 45% SiO_2, 24,5% CaO, 24,5% Na_2O, 6% P_2O_5. Initially, the precursors SiO_2, 24,5% CaO, 24,5% Na_2O were homogenized in a ball mill (Marconi, MA-500) for 2 h, followed by decarbonization in an oven (Jung, LF 00914), dry grinding and melting of the material at 1350° C for 3 h in a fusing furnace (Fortlab, MEV-1700/V). After cooling and drying, the frits were ground. The procedure was repeated from the fusion step.

RESULTS

Bioactive Glass characterization



Raios-X difraction



Raman spectroscopy

Bioactive Glass

Characterization

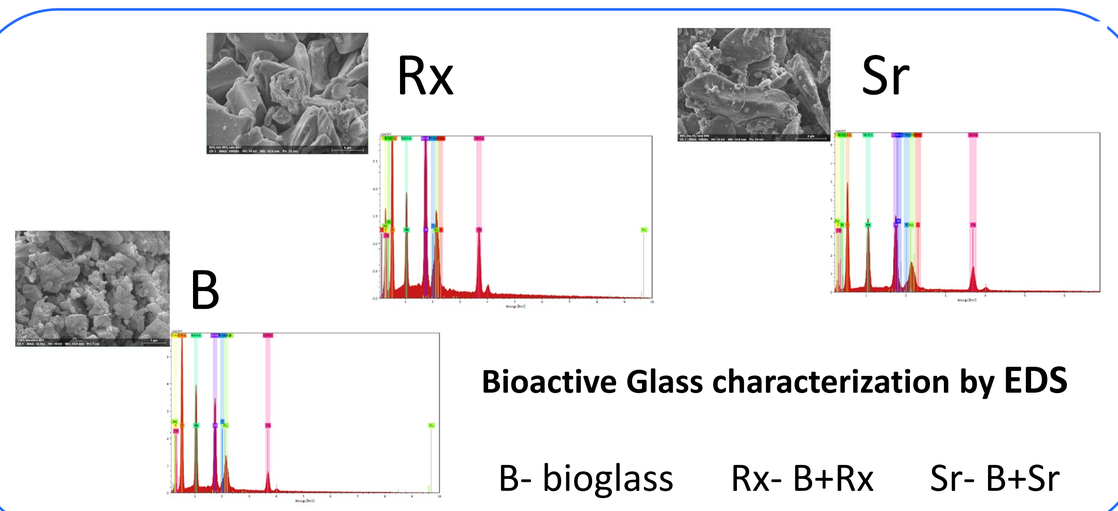
1- Raman spectroscopy
2- Raios X difraction
3- Energy dispersion spectroscopy (EDS)

Functionalization with drugs

Sonochemical route

1- raloxifene (Rx)
2- strontium ranelate (Sr)

Energy Dispersion Spectroscopy (EDS)



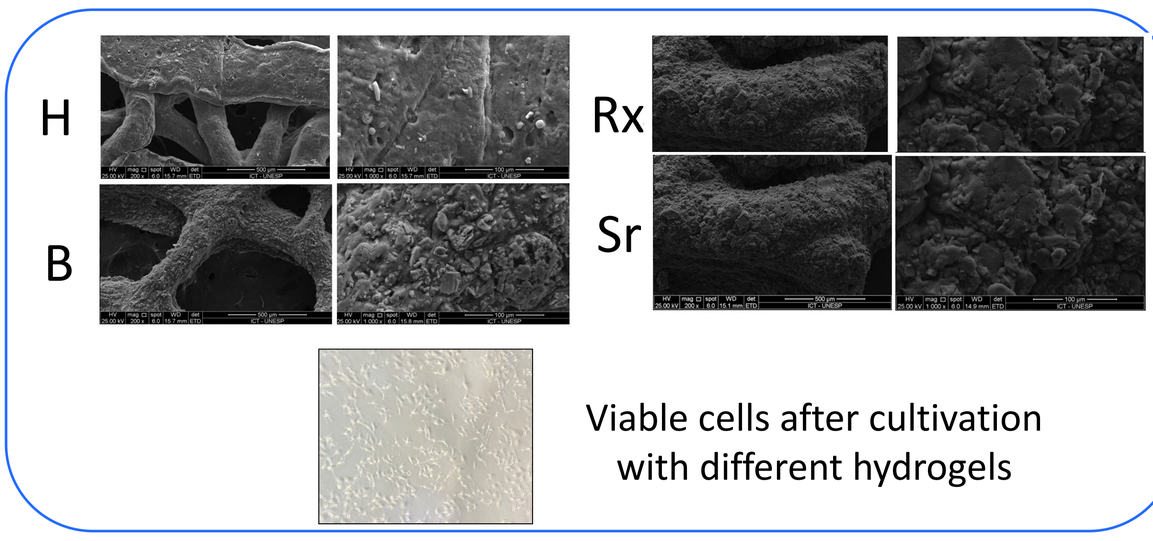
Bioactive Glass characterization by EDS

B- bioglass Rx- B+Rx Sr- B+Sr

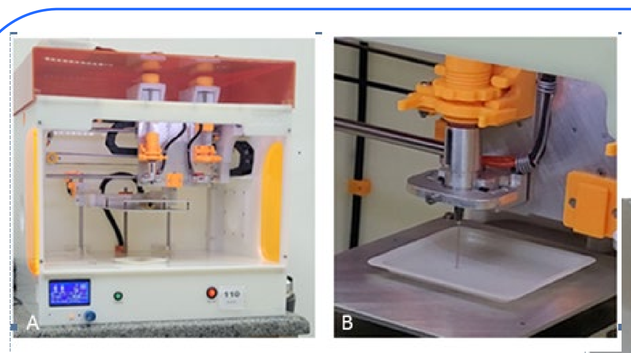
HYDROGEL

In 10ml of distilled water at 55°C, under magnetic stirring, were first added, 2% of bioglass (functionalized with the different drugs), and maintained by magnetic stirring for 20 minutes, after that, the powders were added in the respective order, 0.3% chloride of calcium (anhydrous calcium chloride P.A/ACS), 0.5% gelatin (type A swine skin), and 5% sodium alginate (sodium alginate), then maintained by magnetic stirring for more 20 minutes. After complete cooling of the material, it was inserted into disposable 10 mL syringes coupled to a 22G needle, then the set was positioned in the 3D printer (Genesis I, 3D Biotechnology Solutions), and impressed through the design software (CAD) compatible with the printer.

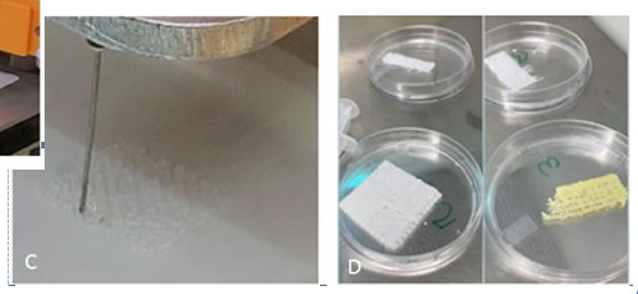
SEM – viable cells



Viable cells after cultivation with different hydrogels



Genesis I Printer, 3D Biotechnology Solutions



After production, they were observed under a scanning electron microscope (SEM)

CONCLUSION

The hydrogels showed promise as they were successfully produced and allowed drug release without being cytotoxic to osteoblast cells.

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