

Development of advanced polymeric scaffolds with natural molecules for modulation of oxidative stress and enhancement of tissue regeneration



Veronica Schiera

Scaffolds for Tissue engineering (TE) and Drug delivery

Veronica.schiera01@unipa.it

Concept

A scaffold is a three-dimensional porous structure that mimics the extracellular matrix (ECM) and supports cell adhesion, proliferation, and differentiation. It is used in two main applications: tissue engineering (TE) and drug delivery systems. These applications demand scaffolds with specific features such as biocompatibility, adequate mechanical properties, bioactivity, biodegradability into non-toxic byproducts, and an interconnected porous architecture. In TE, even with biocompatible materials, scaffold implantation can provoke an inflammatory response, often due to oxidative stress caused by a high local concentration of reactive oxygen species (ROS). Antioxidant molecules are capable of neutralizing excess ROS and exert various biological effects. In this field, polymeric scaffolds loaded with natural antioxidant molecules could modulate oxidative stress conditions and enhance tissue regeneration.

Scientific approach

This research project proposes to produce different types of composite scaffolds. Different polymeric biomaterials will be selected and tested to produce 3D porous scaffolds through several fabrication techniques.

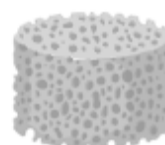
Several natural biomolecules with antioxidant properties will be selected and utilized to obtain composite scaffolds. Moreover, the so-obtained scaffolds might be functionalised with synthetic drugs to improve the efficacy of the system. Morphological (SEM), mechanical (uniaxial compression, cyclic and tensile tests), calorimetric (DSC), water contact angle and FTIR spectroscopy characterizations will be carried out. Finally, biomolecule release and *in vitro* cell culture behavior will be investigated. Once the scaffolds will be optimized, *in vivo* testing will be carried out to determine the benefits of this system in terms of healing and improving tissue functionality.

Research objectives

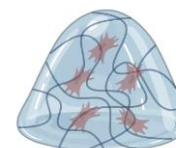
The aim of this PhD project is to fabricate and characterize scaffolds for tissue engineering and drug delivery. The focus is specifically on developing 3D porous and composite scaffolds to regulate oxidative stress conditions and enhance tissue regeneration. Biological tests will be carried out *in vitro* using static cell cultures in multiwell plates, and *in vivo* experiments will be performed on guinea pigs.

Scaffold fabrication

Phase Separation



Hydrogel

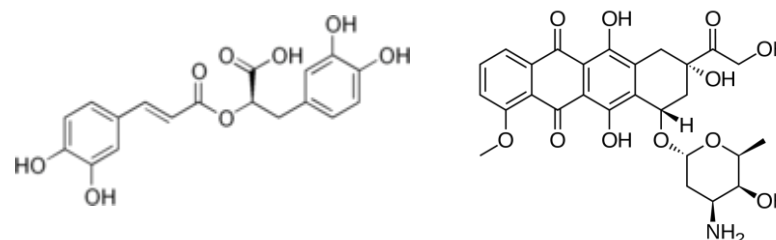


3D printer



Drug loading

Incorporation of natural antioxidant molecules and synthetic drug into polymeric scaffold.



Scaffold characterization

- Mechanical, SEM, DSC, water contact angle (WCA) characterization;
- UV-vis and FTIR spectroscopy.



In vitro and in vivo test

The objective of this study is to evaluate the effect of this composite scaffold

