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AN OVERVIEW OF PROCESSING OF A POLYSACCHARIDE EXTRACTED FROM GREEN ALGAE INTO DIFFERENT MEDICAL DEVICES

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KEYWORDS
Ulvan, biomaterial, tissue engineering

INTRODUCTION

During the past decades, marine organisms have been the focus of considerable attention as potential sources of valuable materials. The sustainable exploitation and valorisation of natural marine resources constitutes a highly attractive and strategic platform for the development of novel biomaterials, with both economic and environmental benefits. In this context, ulvan, a largely unexploited polysaccharide, can be considered as a versatile biodegradable polymer for different applications in a biomedical context. This polysaccharide is extracted from green algae and its interesting properties (Alves 2010, Alves2011, Lahaye2007) justify its study in a highly demanding biomedical arena, particularly its processability into novel medical devices.

METHODS

Ulvan was obtained by extraction from green algae, namely *Ulva lactuca*.

Polysaccharide Processing

Ulvan membranes: Polymeric membranes were produced by solvent casting methodology. In this process, an ulvan solution is placed in an appropriate mould and the solvent is removed by evaporation.

Ulvan 3D porous structures: A polymer solution is prepared, freeze and the solvent removed by lyophilisation under high vacuum.

Ulvan capsules: Ulvan capsules were produced by extrusion-dripping method.

Structures characterization

Ulvan structures were characterized in order to assess different parameters including morphology, mechanical properties and water uptake ability.

RESULTS AND DISCUSSION

In order to understand the limits of processability of ulvan extracted from green algae, different polymer processing methodologies were attempted, including solvent casting to produce ulvan membranes, freeze drying to produce 3D porous structures and extrusion-dripping in order to obtain ulvan capsules.

Table 1: Ulvan membranes' mechanical properties obtained from tensile tests.

	Tensile Strain (%)	Tensile Strength (kPa)	Tensile Modulus (kPa)
Ulvan Membrane	15.2 ± 7.7	44.0 ± 12.0	1760.0 ± 284.0

Produced membranes revealed remarkable ability to up take water (up to ~1800% of its initial dry weight) and good mechanical performance (1.76MPa) (Table 1). The potential of these ulvan membranes to be used as drug delivery devices was assessed and confirmed by using a model drug (dexamethasone) (Figure 1).

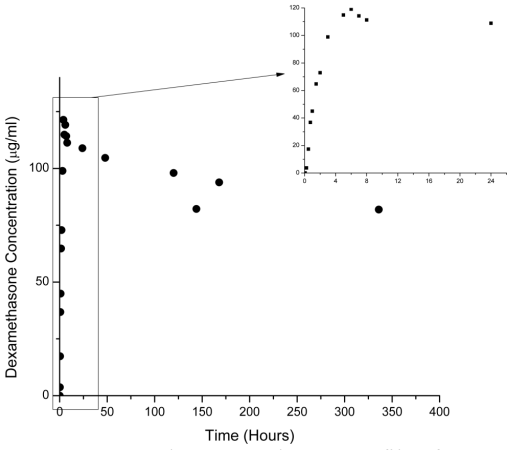

Figure 1: Dexamethasone release profile from ulvan membranes.

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Produced ulvan 3D porous structures revealed remarkable ability to up take water (up to ~2000% of its initial dry weight) and a compressive modulus of 1.52 MPa. On the other hand, produced structures reveal a highly micro-porous nature, enriched with micro-interconnections (Figure 2).

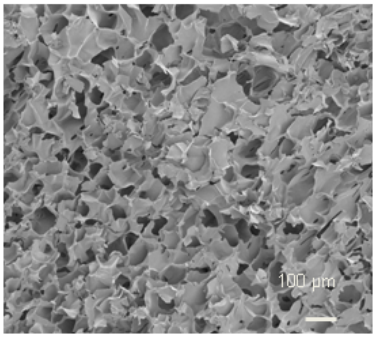

Figure 2: Scanning electron microscopy micrographs of ulvan produced porous structures. (Mag. 250x)

Furthermore, cellular viability and proliferation were evaluated in order to appraise the cytocompatibility of the produced porous structures and their degradation products and by-products of synthesis. These structures undergo a non-toxic degradation and cells remain viable through the time of culture.
Ulvan capsules were formed by static attraction between two opposite charged polysaccharides, ulvan and chitosan. Complexed capsules of ulvan/chitosan present a homogeneous distribution of size, are hollow and exhibit well defined teardrop morphology (Figure 3).

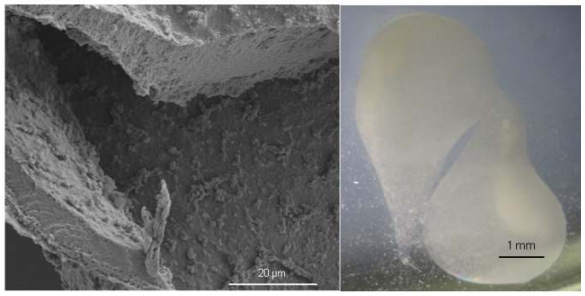

Figure 3: SEM micrograph showing a cross-section detail of an open ulvan capsule - Mag 4000x (left image). Ulvan capsules visualized with a magnifying lens, presenting a tear-drop like morphology: Diameter ~3mm, height ~4.5 – 5mm (right image).

These capsules are able to be loaded with an active agent an act as delivery systems, that can be incorporated within another polymeric matrix and form complex hybrid scaffolds for tissue engineering purposes.

CONCLUSIONS

The knowledge gathered during this work embodies a necessary and crucial step to uncover the innovative biomedical applicability of the marine derived polysaccharide ulvan. Results herein presented contribute further to the establishment of ulvan as biomaterial candidate. Developed structures serve as a stepping stone that confirm the application potential of this material. Future work should focus on additional functionalization of this polymer in order to further optimize physicochemical and biological performance in the context of biomedical applications.

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BIOGRAPHY

ANABELA ALVES was born in Vila Nova de Gaia, in 1981. She moved to Aveiro to get a degree in Biology, at the University of Aveiro. In 2007, she was awarded with a doctoral grant from *Fundação para a Ciência e Tecnologia* to develop her research work on 'Development of innovative tissue engineering scaffolds from algae polysaccharides' at 3B's Research Group.