Production of egg white protein films with antimicrobial properties as food packaging materials

Ângelo Luís[1,2,*], Ana Ramos[2,3], Fernanda Domingues[1,2]

[1]CICS-UBI, Health Sciences Research Centre, University of Beira Interior, Covilhã, Portugal
[2]Chemistry Department, University of Beira Interior, Covilhã, Portugal
[3]FibEnTech-UBI, Fiber Materials and Environmental Technologies Research Unit, University of Beira Interior, Covilhã, Portugal
angelo.luis@ubi.pt / afluis27@gmail.com

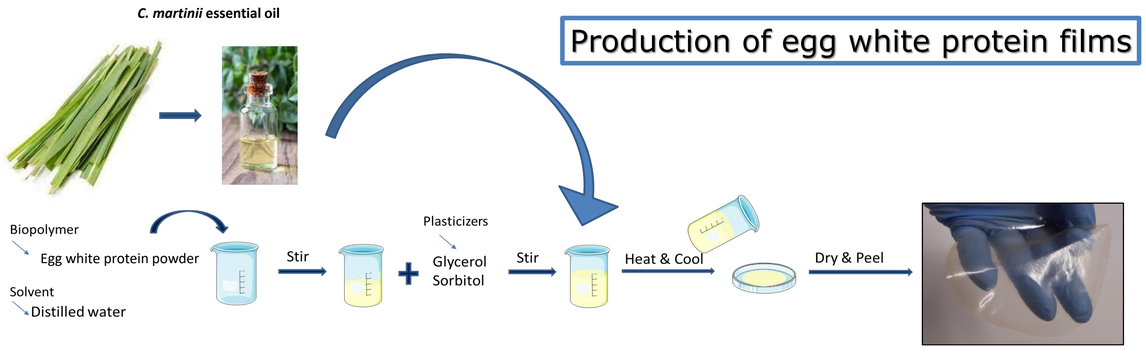
Introduction

- Most of the food packaging is made of plastic materials, which are harmful to the environment since they take a long time to decompose in nature, leading to severe environmental impacts. In this context, natural and sustainable materials are valued because they are more environmentally friendly and can be easily broken down.
- Several raw materials, such as polysaccharides, proteins, and lipids, are commonly used in edible films production.

Objective

- The main goal of this work was to produce and characterize egg white protein films incorporating *Cymbopogon martinii* essential oil as a new food packaging material. The optical, mechanical, and barrier properties of the developed films were assessed. Furthermore, the antioxidant and antibacterial activities of the egg white protein films were also evaluated.

Experimental Methodology



Egg white is a natural endogenous protein that has been widely used in agro-food sectors due to its low cost, high nutritional quality, and excellent functional properties, such as foaming, gelling and emulsification.

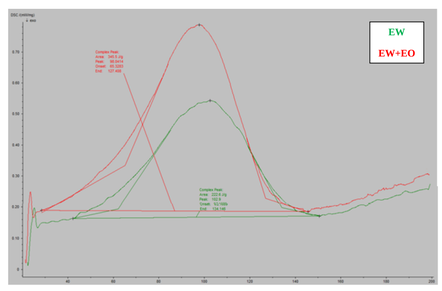
Characterization of the films

- Physical, Mechanical and Optical Properties
- Thermogravimetric analysis (TGA)
- Differential Scanning Calorimetry (DSC)
- X-ray Diffraction (XRD)
- Barrier properties (water vapor and oil permeability)
- Contact Angle and Surface Free Energy
- Antioxidant and Antibacterial activities

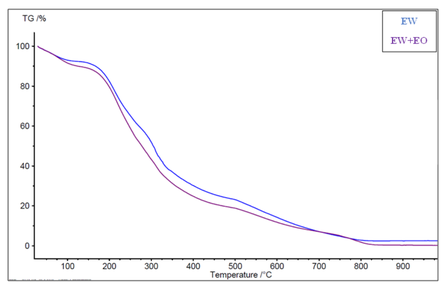
Results and Discussion

Samples	DPPH assay			β-carotene bleaching test
	IC_{50}	AAI	Antioxidant Activity	IC_{50}
Palmarosa EO (*Cymbopogon martinii*) (%, v/v)	2.36 ± 0.43	2.32 ± 0.39	Very Strong	0.74 ± 0.06
Gallic acid (%, m/v)	0.20 ± 0.04	19.62 ± 3.52	Very Strong	-
BHT (%, m/v)	-	-	-	7.70 ± 0.62
p-values	0.012*	0.013*	-	0.002*

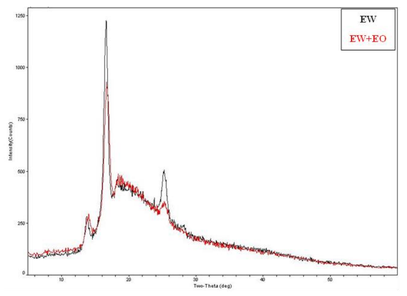
DSC thermograms of the films



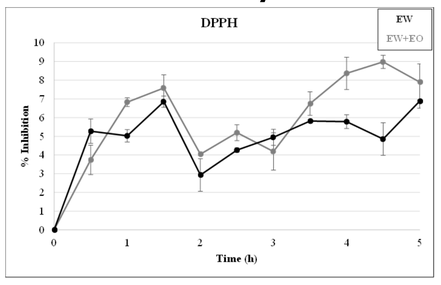
Thermogravimetric analysis of the films



XRD diffractograms of the films



Antioxidant activity of the films



- The chemical composition of the essential oil was studied by GC-MS, being **geraniol** its major compound (**82.04%**). The essential oil demonstrated to possess antioxidant activity measured by DPPH free radical scavenging assay and β-carotene bleaching method.
- The produced egg white films incorporating the essential oil presented **better mechanical properties** than those of the films without the essential oil. The films were **transparent** (**91.81%**) and almost colorless. Concerning the water barrier properties of the films, the incorporation of the essential oil **reduced their water permeation**.
- The antioxidant and antibacterial properties of the essential oil were maintained when it was incorporated in the films, which shown to be antioxidant and active against some **foodborne pathogens**. The incorporation of the essential oil affected the thermal behavior of the egg white films, as the DSC and TGA results shown.

Conclusion

The obtained results indicate that the developed films present a strong potential and are a promising material to develop new biodegradable alternatives to package foods, avoiding the use of traditional plastics.

Ackowledgements

Ângelo Luís acknowledges the contract of Scientific Employment (Microbiology) financed by Fundação para a Ciência e a Tecnologia (FCT) under the scope of DL 57/2016.