Green tea extract and green ionic liquids used as functional additives for chitosan films

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Introduction

It is expected that every aspect of industrial manufacturing can shift to develop environmentally friendly processes in order to obtain functional materials from biodegradable and naturally abundant resources.

Concerning the bioplastic industry, chitosan (CH) is a very promising candidate for production of bio-based materials since it is renewable, non-toxic and biodegradable. CH has been used to develop packaging applications.[1,2]

Green technologies, such as the use of natural deep eutectic solvents (NADES), have been recently used as an environmentally friendly media for plasticizer biofilm and as an extraction medium of bioactive products.[3,4]

In this work, we report the successful use of binary and ternary NADES as a multi-functional medium for the extraction of polyphenolic compounds from green tea (GT). The polyphenols extracted were used for the production of CH bio-films. Transparent films were obtained and evaluated in terms of water resistance, optical and microstructural properties and thermal properties. Significant differences were verified in the biofilm's microstructural properties, hygroscopic and thermal behaviour for the NADES type and content considered.

Extraction of polyphenolic compounds

NADES:
NADES1 - ChCl/lactic acid (LA) 1:2
NADES2 - ChCl/gluceryl (Gly) 1:2
NADES3 - Ch/UL/AlGly 1:1:1

CH (3% w/w) (DIH= 78%) pH= 5.70
Adjusted with acetic acid

Film production – Casting method

Two systems: CH films with and without addition of NADES or NADES/GT.
Films with NADES and NADES/GT extracts (10%, 20% and 30% w/w).

Film characterization

Scanning Electron Microscopy (SEM)
Experiments were carried out at CEMUP, Porto, Portugal.

Optical properties (colour and opacity)

Swelling Index (SI)

Water Vapour Permeability (WVP)

WVP = \( \Delta m \cdot x / A \cdot t \cdot \Delta p \)

Results and discussion

Swelling Index (SI)

Similar increase of water retention capacity evolution was observed.

Despite the process being very fast for all the samples, it depends on the type of NADES used.

Addition of NADES had a noticeable impact on biofilm’s colour.

The films tended to be green (-a*) and yellow (+b*).

NADES-1 films and NADES-2/GT were the most transparent’s biofilms.

Water Vapour Permeability (WVP) and Thickness

Table 1 - WVP and thickness, \( \delta \), of values of investigated films with 20% of plasticizer

<table>
<thead>
<tr>
<th>Films</th>
<th>WVP (g( \cdot )cm( \cdot )s( \cdot )m( \cdot )Pa( \cdot )1( \cdot )10( ^{-10} ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chit</td>
<td>0.085 ± 0.006</td>
</tr>
<tr>
<td>Chit-NADES1-20%</td>
<td>0.075 ± 0.003</td>
</tr>
<tr>
<td>Chit-NADES2-20%</td>
<td>0.081 ± 0.004</td>
</tr>
<tr>
<td>Chit-NADES3-20%</td>
<td>0.076 ± 0.007</td>
</tr>
<tr>
<td>Chit-NADES1-20% GT</td>
<td>0.076 ± 0.005</td>
</tr>
<tr>
<td>Chit-NADES2-20% GT</td>
<td>0.071 ± 0.002</td>
</tr>
<tr>
<td>Chit-NADES3-20% GT</td>
<td>0.079 ± 0.004</td>
</tr>
</tbody>
</table>

Films prepared with Chit show higher thickness values than plasticizer films.

Films with NADES showed different WVP from the unplasticized film.

Within films containing NADES/GT extraction (Table 1), the lowest value was displayed by Chit-NADES3-GT.

Conclusions

CH biofilms (with and without binary and ternary NADESs), produced by casting method, present compact, homogenous and transparent structure.

Ternary NADES (ChCl/lactic acid/glycerol) exhibit great potential to be used as a plasticizer for polysaccharides biofilms.

The results obtained suggest, that by varying the composition/structure of these potentially biodegradable films, the morphology as well the water resistance proprieties of the films can be altered.

References
1. [reference]
2. [reference]
3. [reference]
4. [reference]
5. [reference]
6. [reference]
7. [reference]
8. [reference]