HYDROLYTIC DEGRADATION OF A NEW TERPOLYESTER BASED ON TARTARIC ACID

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Introduction

In recent years, biodegradable polymers have attracted considerable attention as biomaterials in pharmaceutical, biomedical engineering applications, including drug delivery systems, implants and functional materials in tissue engineering.[1] Several aliphatic polyesters such as poly(lactide) (PLA) and poly(ε-caprolactone) (PCL) have attractive biodegradability and biocompatibility and are produced in industrial scales. However, they have low mechanical properties. Introducing aromatic units into the main chains of aliphatic polyesters may be an effective strategy to prepare new aliphatic-aromatic copolyesters, capable of its combination of desirable biodegradability and good mechanical properties.[2] The biodegradability of aliphatic/aromatic copolyesters is strongly affected by composition, sequence distribution, crystallinity, structures of crystallites, and melting temperatures.[3] It has been reported that copolysters with up to 60 mol % aromatic units are biodegradable, though the content of terephthalic fragments in polymer chain greatly influences the degradation rates.[4]

L-tartaric acid is a readily available, cheap, natural compound formed in large quantities in the wine industry. Due to its non-toxicity is often used i.a. as a food additive. Moreover, there is a little information about tartaric acid based polymers containing hydrophilic groups, which additionally accelerate the hydrolytic degradation.[5] In contrast to polylactic having hydrolytic sensitive ester bonds, P(AC) contains additionally ester as well as ketal groups in the polymer chains.

We obtained polyester that consists of terephthalate units that provide good mechanical properties and tartrate, which accelerate degradation rates. In our paper we present the degradation results of a new tartaric acid-based polyester, which under certain conditions (pH <7) readily undergoes hydrolysis to hydroxyl groups, which leads to an increase of degradation rate. In vivo studies showed that the polymers based on tartaric acid are also characterized by good biocompatibility.[6]

Results and Discussion

In our work we present the degradation studies of a new tartaric acid-based terpolyesters formed from aliphatic polyester P(AC) and poly(propylene terephthalate-co-succinate) P(PTS) (Scheme 2). P(AC) was obtained from tartaric acid derivate - dimethyl 2,3-O-isopropylidene-L-tartrate and 1,3-propanediol (Scheme 1).[7] The proposed polymer preparation methodology consisted of the synthesis of polyester based on tartaric acid P(AC) and poly(propylene terephthalate-co-succinate) P(PTS) followed by their transesterification, which was carried out at 200 °C under reduced pressure of 2 mmHg within 3 hours. The hydrolytic degradation was performed in pH = 2.0 phosphate buffer solution at 37 ºC and it was monitored by mass loss. The highest degradation rate was observed for the 30 mol.% content of P(AC) as expected (Figure 1).

Scheme 1. The synthesis of polyesters P(AC) from dimethyl 2,3-O-isopropylidene-L-tartrate and 1,3-propanediol.
Scheme 2. The synthesis of terpolymer from aliphatic polyester P(AC) and aliphatic-aromatic copolyester P(PTS).

Table 1. Molecular weights of polyesters.

<table>
<thead>
<tr>
<th>No</th>
<th>mol. % of P(AC)</th>
<th>Molecular weight (M&lt;sub&gt;n&lt;/sub&gt;)</th>
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<tr>
<td></td>
<td></td>
<td>P(AC)</td>
</tr>
<tr>
<td>1</td>
<td>10</td>
<td>9500</td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td>9500</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>9500</td>
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</tbody>
</table>

Figure 1. Hydrolytic degradation of a new terpolyesters with 10%, 20%, and 30 mol.% of polyester based on tartaric acid.

Conclusion

The application of aliphatic and aromatic polyesters led to obtaining aliphatic-aromatic terpolyester that combine desirable degradability and good mechanical properties.

This work has been supported by the European Union in the framework of European Social Fund through the Warsaw University of Technology Development Programme.

References