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MODIFICATION OF HIGH MOLECULAR WEIGHT POLY-3-HYDROXYBUTYRATE BY INTRODUCING ITS FUNCTIONALIZED OLIGOMERS

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Abstract. Biocompatible polymers are essential for reconstructive medicine; a promising group of them are polyhydroxyalkanoates, polyesters of microbiological origin. However, their most widespread and studied representative, poly-3-hydroxybutyrate (PHB), has a relatively high hydrophobicity, which in some cases prevents normal interaction with the biological media of the body and cell adhesion[1]. One of the solutions is the introduction of biocompatible modifying additives (including other biocompatible polymers) into the structure of the polymer matrix. In this work, a "homopolymer" blend of high molecular weight PHB and its oligomeric derivatives, obtained by its degradation under the influence of bifunctional amines, was studied.

Aminolysis of the initial high molecular weight poly-3-hydroxybutyrate (HMW-PHB) with ethylenediamine and 1,4-diaminobutane in dimethylformamide yielded its oligomers (low molecular weight PHB, LMW-PHB) with a weight average molecular weight of 5.6 kDa and 4.0 kDa, respectively. The oligomers were mixed with high molecular weight PHB in solution in different ratios (10%, 30% and 50% of the oligomeric component). The solvent evaporation method was used to prepare the corresponding blends in the form of films.

At a low (10%) content of LMW-PHB in the mixture, the surface hydrophilicity values (free surface energy, contact angle of wetting with water) did not change significantly in comparison with pure HMW-PHB films. As the content of LMW-PHB in the mixture augmented, the hydrophilicity also increased: the contact angle decreased from 84° to 72–76°, and the polar component of the free surface energy changed from 2.7 to 5.3–6.9 mN/m. With the addition of LMW-PHB, a gradual decrease in the tensile strength was registered from 33.46 for pure HMW-PHB to 7–8 MPa at a content of 50% LMW-PHB. Young's modulus also decreased, but its drop did not exceed 20% (from 3.7 GPa in the control to 2.9 GPa with 50% content of "ethylenediamine" oligomers). The elongation at break was 1.23% for the HMW-PHB films and less 1% for the rest of the samples. A significant increase in the level of adhesion of NIH 3T3 mouse fibroblasts on the surface of the films was noted when LMW-PHB was introduced into the polymer matrix.

In general, the applicability of a method based on the introduction of a hydrophilic functionalized filler (for example, aminated PHB oligomers) to improve the biocompatibility of biopolymer products was shown.

References

1. Biomedical applications of polyhydroxyalkanoates, an overview of animal testing and in vivo responses / SP Valappil, SK Misra, A. Boccaccini [et al.] // Expert Review of Medical Devices. - 2006. - Vol. 3. - P. 853-868.

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