MECHANICAL PROPERTIES OF COMPOSITE SCAFFOLDS FROM POLY(3-HYDROXYBUTYRATE) AND SODIUM ALGINATE

Anton Bonartsev[1]*, Vsevolod Zhuikov[2], Irina Zharkova[1], Elysabeth Akoulina[2], Vera Voinova[1], Garina Bonartseva[2], Konstantin Shaitan[1]

[1] Faculty of Biology, M.V. Lomonosov Moscow State University, Leninskie gory, 1-12, 119234, Moscow Russia
[2] A.N. Bach Institute of Biochemistry, The Federal Research Centre "Fundamentals of Biotechnology" of the Russian Academy of Sciences, Leninsky Ave., 33, bld. 2, 119071, Moscow, Russia
*e-mail: ant_bonar@mail.ru

[Engineering of Biomaterials 143 (2017) 89]

Introduction

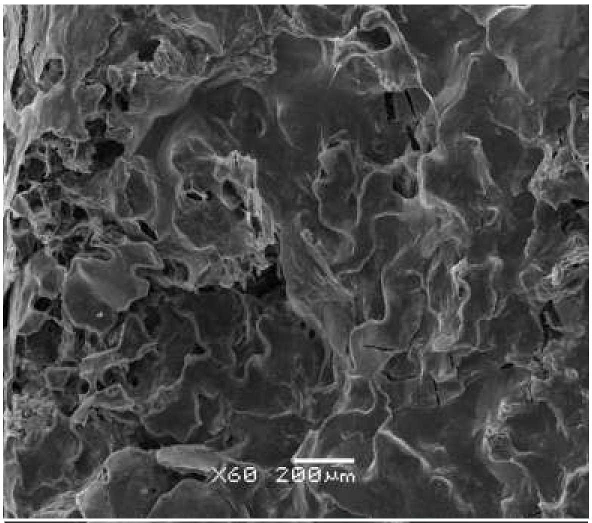
Recent years biodegradable polymers of natural origin, poly(3-hydroxyalkanoates) (PHAs) and alginates (ALGs), have found broad application in medicine and tissue engineering. These polymers are very different in their properties: PHAs are hydrophobic, mechanically strong polyesters, while alginates are hydrophilic, hydrogel-forming, mechanically destructible polysaccharides. However these polymers bring together the fact that PHAs and ALGs can be produced biotechnologically allowing to regulate their properties [1,2]. Particularly, development of composite constructions from these polymers makes it possible to adjust the selected properties, especially mechanics, of the resulting composite PHAs/ALGs constructions for bone and cartilage engineering, where PHAs and ALGs are widely used. Thus, the objective of the work was to create the composite scaffolds from poly(3-hydroxybutyrate) (PHB) and sodium alginate (ALG).

Materials and Methods

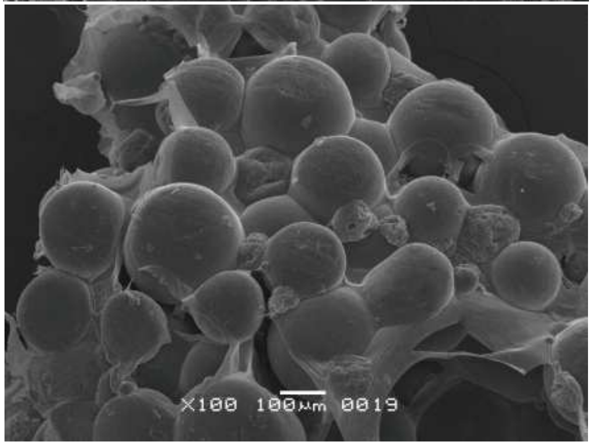
Two types of PHB/ALG constructions were manufactured: porous constructs from PHB filled with ALG hydrogel (ALG-in-PHB) and ALG hydrogel embedded with PHB microspheres (PHB-in-ALG). The PHB porous constructs used in this work were manufactured by two-stage leaching technique using two blowing agents: ammonium carbonate and sucrose and then filled with ALG with hydrogel formation. PHB microspheres were produced by two-stage emulsification technique and then mixed with ALG to produce hydrogel. Various PHB/ALG composite construction with different parameters: pore size, microspheres diameter, microspheres content, hydrogel density were produced. The morphology of composite scaffolds was investigated by scanning electron microscopy (SEM) and by wide-field light microscopy (WLM). The mechanical properties of obtained constructions were measured by rheometry.

Results and Discussion

The Young's modulus of obtained PHB/ALG composite scaffolds varied from 9 to 178 kPa. The complicated dependence between mechanical properties and morphological features of PHB/ALG composite scaffolds was revealed and analysed. Morphological features (e.g. pore size, microspheres diameter, porosity) of produced scaffolds effect greatly on its mechanics: e.g. increase in diameter of microspheres from 50 to 500 mkm caused 6-fold increase in Young's modulus of PHB-in-ALG scaffolds.



a)



b)

FIG. 1. SEM microphotographs of ALG-in-PHB (a) and PHB-in-ALG scaffolds (b).

Conclusions

In general, PHB microspheres reinforced PHB-in-ALG scaffolds more efficiently than PHB porous structures ALG-in-PHB scaffolds. Further the technique of hybrid PHB/ALG scaffolds production will be used to develop biocomposite scaffolds and fillers for bone tissue engineering.

Acknowledgments

This work was supported by RFBR ofi_m grant, project No 15-29-04856.

References

[1] A. Bonartsev, I. Zharkova *et al.,* Preparative Biochemistry and Biotechnology, 47 (2017), 173-184.
[2] G. Bonartseva, E. Akulina *et al.,* Applied Biochemistry and Microbiology, 53 (2017), 51–58.