Plastics, Packaging materials, Consumer goods

Development of marine biodegradable bioplastics based on starch

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Abstract

Plastic has enriched our daily life with its excellent properties such as low cost, lightweight, and design adaptability. However, since most plastics do not biodegrade in the natural environment, marine plastic garbage has come serious as a social problem in recent years, and countermeasures are urgently needed. We have studied marine biodegradable biomass plastics by blending starch with biodegradable plastics. Developed polysaccharide composite/blended plastics, promoted the practical use of polysaccharide blended plastics equipped with a switching function that induces marine biodegradability, and achieved significant improvements in heat resistance and impact resistance of bioplastics.

Background & Results

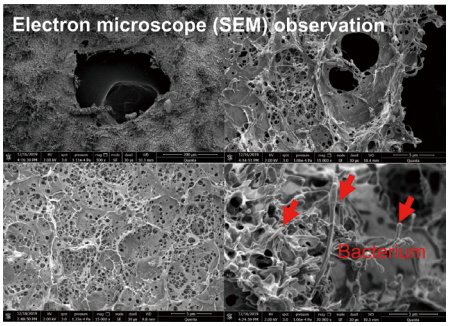
Since most plastics are petroleum-derived and do not biodegrade in the natural environment, marine plastic garbage has attracted attention as a major social problem. Marine biodegradable plastics that can be used as a countermeasure are limited to some of aliphatic polyesters, and in addition to low production volumes compared to general-purpose plastics, they are also expensive. Starch is abundant in nature, cheaper than common petroleum-derived plastics or aliphatic polyesters, and suitable for industrial production. Also, although starch is not generally considered a marine biodegradable plastic, it is inherently a marine biodegradable polymeric material. Therefore, in this research, we used starch as a raw material to create a marine degradable plastic material that has a low environmental impact throughout its life cycle. By compounding starch with cellulose nanofibers, the disadvantage of starch, such as water resistance and mechanical strength, can be improved. Recently, we have started a marine biodegradable bio-based plastics (MBBP) development platform, which enables a variety of moldings by blending biodegradable plastics such as poly(lactic acid) and poly(butylene succinate) with thermoplastic starch (TPS). We are aiming to develop MBBP, prepared using TPS from cassava starch, and prototypes were developed by various molding methods. The developed MBBP has (1) biodegradability, (2) physical properties comparable to common plastics, (3) price competitiveness, and (4) thermoplasticity that enables a wide range of plastic moldings. The spread of MBBP in society is expected to contribute to resource recycling and circular economy through the active use of biomass, and to solve the problem of marine plastic garbage by incorporating marine biodegradation functions into plastic products.

Significance of the research and Future perspective

This technique provides an alternate pathway to alleviating the problem of marine plastic garbage, and could be possibly useful for single-use applications in different fields such as packaging, healthcare, and agriculture. Furthermore, a new method to prepare starch based marine biodegradable plastics with improved mechanical properties by introducing hemiacetal crosslinking has not yet been reported, and could be a paradigm shift for the development of socially important biodegradable materials. It is very interesting not only from the point of view of functional material development, but also from the perspective of industrial development in the environmental field that contribute to global conservation.

Prototypes of starch-CNF composite

MBBP prototypes



Marine biodegradable starch-CNF composite

Patent	Japanese Patent No. 4942436, Japanese Patent No. 5057874, Japanese Patent No. 5495360
Treatise	Soni, Raghav; Hsu, Yu-I; Uyama, Hiroshi. Synergistic effect of hemiacetal crosslinking and crystallinity on wet strength of cellulose nanofiber-reinforced starch films. Food Hydrocoll., 2021, Vol. 120, pp. 106956 (1-10). doi: 10.1016/j.foodhyd.2021.106956
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