Polyhydroxyalkanoates and chitin: sustainable, bio-based, biodegradable plastics with applications in the circular bioeconomy

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We continue to seek biodegradable alternatives to petroleum-based plastics. Traditional plastics are known to be strong and durable, to the point that when discarded, they persist in the environment. Eventually petroleum-based plastics do break down, resulting in microplastics that contaminate environments, as well as marine and terrestrial organisms. Chitin and polyhydroxyalkanoates (PHAs) are two naturally occurring polymers that are durable yet can be enzymatically mineralized in the environment. Chitin, the second most abundant polysaccharide in nature, is a structural polysaccharide found in crustacean shells and fungal cell walls that exhibits favorable biological, chemical and mechanical properties. Polyhydroxyalkanoates are a family of carbon storage polymers that can be modified *in vivo* to produce strong, flexible thermoplastics. One potential application for chitin and PHA materials is in medical products, specifically wound healing agents. We have examined membranes composed of both polymers and demonstrated their material properties and how they could be used in wound healing applications. Chitin membranes fabricated by solvent casting using the ionic liquid [C2mim][OAc] were shown to be durable, flexible and porous. These membranes were shown to be suitable as physical substrates for growth of mammalian cells and for release of bioactive compounds. Membranes were also fabricated using purified, methyl isobutyl ketone (MIBK)-cast PHA. These PHA membranes were also demonstrated to be durable, flexible and porous. Three different PHA copolymers were tested: poly(3-hydroxybutyrate-*co*-17mol%hydroxyhexanoate) [P(HB-*co*-17mol%HHx)], P(HB-*co*-23mol%HHx), P(HB-*co*-30mol%HHx). We observed that the higher amount of hydroxyhexanoate (HHx) monomer in the material, the tougher and more flexible was the fabricated membrane, and the greater reduction of melting temperature and crystallinity. Porous, solvent-cast and electrospun PHA membranes were impregnated with lysozyme and tested on growing bacterial cultures. The lysozyme-loaded membranes were shown to inhibit biofilm formation *in vitro*. Chitin membranes were shown to be suitable as physical substrates for growth of mammalian cells and for release of bioactive compounds. Blending of chitin with hydroxyapatite or polylactide (PLA) altered the material properties and supported growth of osteocytes. These proof-of-concept results suggest opportunity for further study of chitin and PHA as wound dressing material.