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Enzymes immobilized on cellulose carriers: Renewable, biodegradable and economical

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PURPOSE OF THE ABSTRACT

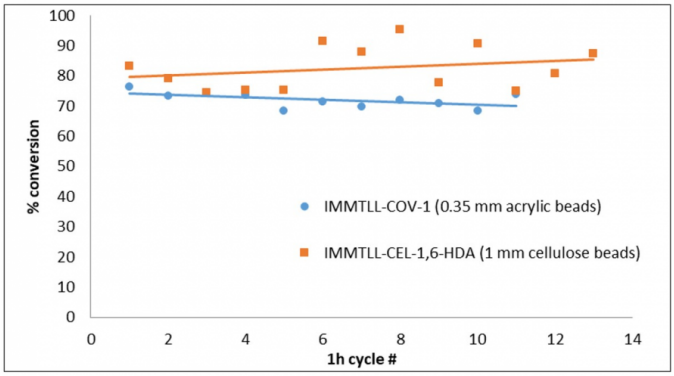
An increasing range of carriers with a wide choice of enzymes suiting both batch and continuous processes are commercially available. Macro- and gigaporous carriers suitable for any enzyme are on the market for large scale usage and guarantee minimized costs. As a result of these developments, the number of industrial applications is steadily growing and the ongoing progress will ensure continued success in meeting new challenges. Readily available renewable carriers are missing from this range of carriers, however.

To make a 'green process greener' cellulose beads can be used as enzyme carriers to replace non-renewable polluting plastic beads currently used in most industrial biocatalytic processes. Cellulose is a natural biopolymer extracted from wood, a renewable feedstock that can be sourced sustainably. Cellulose is thermally and mechanically stable while at the same time being biodegradable in the presence of microbes (e.g. in wastewater treatment sludge).

In collaboration with Naturbeads (Bath University) a new cellulose carrier was developed that can act as a replacement for standard acrylic beads. The cellulose beads have well defined properties such as uniform size, spherical shape and high porosity (>90% pore volume). A series of experiments was run to introduce a variety of functional groups including covalent and ionic binding groups. This functionalization allows for binding of enzymes via different binding modes ensuring high loading, good activity recovery and stable performance.

Various enzymes were immobilized on the functionalized cellulose beads and subjected to biphasic process conditions. With a group of lipases hydrolysis tests were run at 40 ˚C in a Spinchem rotating bed reactor and for each formulation at least 10 recycles were performed. The best performing ones - among which lipase from Thermomyces lanuginosus – showed equal to even better performance and recyclability compared to the same amount of enzyme immobilized on a standard epoxide acrylic beads. This proofs that an enzyme immobilized on a cellulose bead can be a biodegradable and renewable alternative for plastic beads while at the same time having better economics.

FIGURES



Graph 1: MCT oil hydrolysis by an equal amount of lipase immobilized on acrylic or cellulose beads in a Spinchem rotating bed reactor.

FIGURE 1

Graph 1

MCT oil hydrolysis by an equal amount of lipase immobilized on acrylic or celluose beads in a Spinchem rotating bed reactor.

FIGURE 2

KEYWORDS

enzyme immobilization | renewable | biodegradable | cellulose

BIBLIOGRAPHY