Chapter 57
Enzyme-Triggered Hydrogels for Pharmaceutical and Food Applications

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ABSTRACT

Enzyme-mediated polymeric hydrogels are drawing considerable attention in pharmaceutical and food sectors owing to their superior biocompatibility and process controllability under physiological conditions. Enzymes play a significant role in polymeric hydrogel formation through different mechanisms. Oxidases (e.g., horseradish peroxidase and tyrosinase) have demonstrated to drive the crosslinking of gel precursors by oxidizing the phenolic or acrylic moieties to free radicals. Transferases and hydrolases catalyze elongation of biopolymer chains which gradually self-assemble into hydrogels. Still more certain enzymes also participate in hydrogel formation by releasing gelation factors. Enhancement of the desired properties of certain hydrogels through the interior and exterior post-modifications has also been demonstrated by certain enzymes. Hence, in this chapter, the authors explore the different mechanisms of enzyme-mediated hydrogels preparations and its fabrication towards pharmaceutical and food sectors along with the discussion of recent trends and further prospects.

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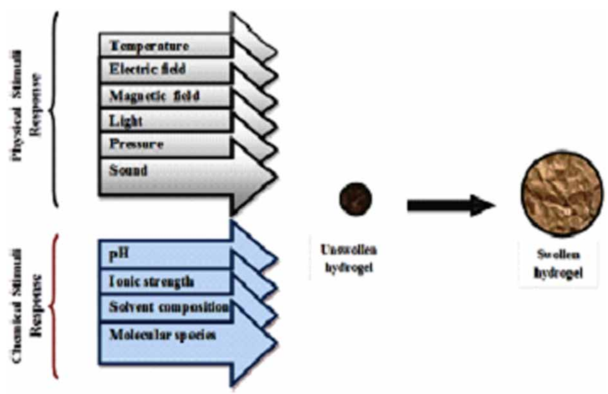
INTRODUCTION

Hydrophilic gels that are networks of polymer chains in which water is the dispersion medium (Jonker, Borrmann, van Eck, van Delft, Löwik, & van Hest, 2015). Elastic networks with interstitial spaces contain as much as 90-99% w/w water. Hydrophilic groups attached to the polymeric backbone confer the potency to absorb water to the hydrogels while the property of resistance to dissolution arises from cross-links between network chains. Many materials, both naturally occurring and synthetic, fit the definition of hydrogels (Jonker, Borrmann, van Eck, van Delft, Löwik, & van Hest, 2015; Singh, Topuz, Hahn, Albrecht, & Groll, 2013).

Figure 1. Representation of hydrogel



Ideal Functional Features of a Hydrogel

- Maximum absorption/equilibrium swelling capacity in saline.
- Optimal desired rate of absorption (preferred particle size and porosity) depending on the application requirement.
- Maximum absorbency under load (AUL).
- Minimum soluble content and residual monomer.
- Least price.
- Maximum durability and stability in the swelling environment and during the storage.
- Phenomenal biodegradability without formation of toxic species following the degradation.
- pH-neutrality after swelling in water.
- Non toxic, Colorlessness, odorlessness etc.
- Photo stability.
- Re-wetting capability (if required) the hydrogel has to be able to give back the imbibed solution or to maintain it; depending on the application requirement (e.g., in agricultural or hygienic applications).

Optimization of the hydrogel production reaction variables must be executed to achieve an appropriate balance between the properties since a hydrogel with all the mentioned attributes is practically not feasible.