

Cyclodextrins in active packaging

Active packaging serves not only as a passive barrier designed to delay adverse effects of the environment on the packaged item, e.g., food, but allows interaction between the packaged goods and the environment. It controls moisture, oxygen, may contain antibacterial and/or antifungal agents to reduce food degradation and extend shelf life. The packaging material contacting food requires extra care in leaching the components (can diminish the release of plasticizers and other harmful compounds and control the release of the bioactive preservative components to maintain a low concentration for a long time).

Cyclodextrins are cyclic oligosaccharides able to form inclusion complexes with apolar substances.

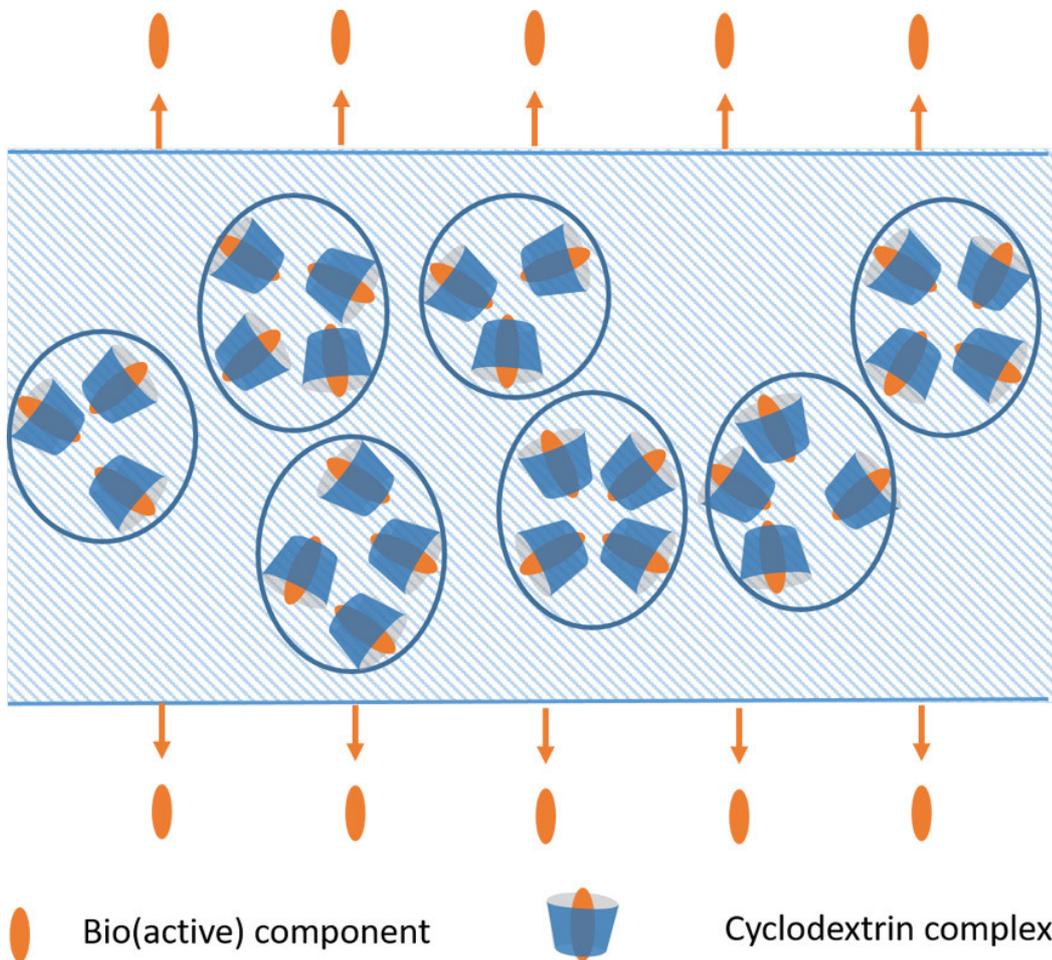


Fig. 1. Controlled release of active components such as fragrance, fungicide, pesticide, UV absorber, odorants, deodorants, and hundreds of other additives incorporated in the polymer matrix in cyclodextrin-complexed form.

Incorporating empty cyclodextrins into the packaging material an aroma barrier packaging is produced, which decelerates the loss of the aroma from the packaged food, prevents the penetration of undesired volatile

pollutants from the environment, like components of exhaust gases, airborne toxins, cigarette smoke, and reduces the migration of plasticizers, residual solvents and monomers, etc. Applying cyclodextrins in active packaging allows to preserve the quality of food and ensures a longer shelf-life for the packaged items.

Cyclodextrin complexes of fragrances, antimicrobial agents, dyes, insecticides, insect repellents, UV-filters can be incorporated into polymers (packaging films, bottles, trays and containers) to ensure either the slow release or a homogeneous distribution of the complexed substances. This way the propagation of microorganisms on surface of enwrapped products is decelerated, or the product is made more attractive by slowly released fragrances, protected against UV-light-induced deterioration, oxidation, etc. The trigger for the release is humidity, making these materials especially useful for packaging the moisture-containing food items.

Active packaging materials can be produced for specific purposes, incorporating and slowly releasing active substances. Application of these active substances in cyclodextrin-complexed form has several advantages:

- The packaging materials are usually produced at elevated temperature (over the melting point of the polymer, generally between 100 and 200 °C). This temperature is generally high enough to cause a considerable loss through volatilization or thermal conversion (degradation, isomerization) of the (bio)active ingredient. This loss can be avoided if the (bio)active component is mixed with the polymer in cyclodextrin-complexed form. The dry cyclodextrin complexes of these substances are generally stable up to the thermal degradation temperature of the cyclodextrin (220 to 250 °C).
- Incorporation of cyclodextrin-complexed (bio)active substances into the polymer matrix do not reduce its chemical stability.
- Preparing such packaging materials, relatively small amount of the (bio)active components are distributed evenly over a large surface, to exert their effects on the surface of the packaged goods either by direct contact, or in the gas-phase within the closed package. The prerequisite of effective blending of cyclodextrin-complexed actives into the polymer phase is the compatibility of the components. Masterbatches of various cyclodextrin complexes combined with low-density polyethylene can be added during plastic processing and the complex is “fused” into the plastic, this way enabling the plastic manufacturer to add various components to plastic and other resin-based products. These masterbatches are compatible with a number of plastics.
- The release of the complexed and polymer-incorporated (bio)active substances depends on the hydrophobicity of the matrix, permeation of water into the polymer, particle size of the complex incorporated, temperature, presence of other hydrophilic components, etc. The release must be slow to avoid the permeation of significant fraction of the (bio)active component into the packaged goods. This can be tuned by applying proper cyclodextrins.

New packaging materials must be biodegradable to avoid further environmental pollution. The biodegradability is a further advantage of utilization of cyclodextrins in packaging.

We have recently published a review with several examples and 126 references on application of cyclodextrins in composite polymers for active packaging.

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Publication

[Cyclodextrin-Enabled Polymer Composites for Packaging](#)

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