Abstract

Process Economics Program Report 250

BIODEGRADABLE POLYMERS FROM PLANTS

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Polyhydroxyalkanoates (PHAs) are biodegradable polyesters produced by numerous microorganisms as intracellular energy reserves. The metabolic pathway from these microorganisms can be bioengineered into a variety of plants for making PHAs. While this new scheme for producing biodegradable polymers is not yet commercial, it may have the potential for large scale manufacture at very low cost. There has been significant research done by government, academic and commercial organizations over the past decade into bioengineering plants for this purpose.

Numerous challenges, both technical and non-technical, are associated with commercializing this form of biotechnology. One challenge is to achieve a high level of polymer production in the plant without a decrease in crop yield. Another is to economically recover the polymer from the plant biomass. In the case of commercial crop systems such as oilseed crops, it is important that oil and meal also be recovered from the seed to capture their commercial value.

In addition to the technical challenges of commercializing this technology, there are also large non-technical barriers. These barriers are associated with the utilization of agricultural infrastructure for production of industrial products. Identity preservation of PHA crops needs to be provided within the infrastructure and could potentially be quite costly. Another barrier is managing public opinion of biotech crops. These issues could be more important than the technical issues when considering overall production costs.

In this report, PEP presents process designs and associated cost estimates for the production of polyhydroxyalkanoates in agricultural crops. The economics are compared to those for PHA production by *E. coli* fermentation. Process economics are also provided for a typical oilseed crushing plant. The general conclusions are summarized below:

- PHA by E. coli fermentation offers promise as a means to profitably produce commercial polymer. Increasing the plant capacity and utilizing E. coli as the fermentation bacteria significantly improve the process economics compared to those estimated in PEP Report 115C published in 1998.
- PHA from bioengineered crops could potentially be cheaper than fermentation, but a number of technical and non-technical hurdles must be overcome first. From both a cost standpoint as well as public acceptance and identity preservation standpoints, switchgrass is preferred to an oil seed crop for producing PHAs on a large scale.

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