SENSE AND NON-SENSE ABOUT POLYMERS

Herman Feil*

Department of Polymers, Carbohydrates and Fatty Acids, Agrotechnological Institute (ATO-DLO), P.O. Box 17, 6700 AA Wageningen, the Netherlands

Abstract: This paper describes the present developments and future opportunities for industrial biopolymer applications.

INTRODUCTION

In the past 15 years, the development of bioplastics as an alternative for petrochemical plastics has received much attention from industry, academia, and politics. The rationale for these developments has mostly been the desire to reduce the amount of solid waste. While 15 years of development is relatively modest compared to the time and effort that has been invested in the development of useful synthetic plastics, various types of bioplastics are now on the market and possess interesting and useful properties for a number of applications.

In this paper, the present status of the development and applicability of bioplastics is described. In addition, the research approach of ATO-DLO, which is involved in the development of different types of bioplastics, towards the development of bioplastics is described, together with the new trends and possibilities for biopolymers.

 CCC 1022-1360/98/$ 10.00

STATE OF THE ART

Bulk plastics

The development of bioplastics has been focused mostly on the bulk plastics market. The goal for most companies has been to produce plastics which can be used for short term-applications, such as disposables (e.g. cutlery, coffee cups), garbage bags, etc., for which the solid waste problem is most urgent.

Presently, there are four types of bioplastics which appear to be most promising, which are polyhydroxy alkanoates (PHA's), polylactides (PLA), cellulose-derivatives, and thermoplastic starches. The plastics with the lowest price, and the highest current market share are the thermoplastic starches. Sales, which were virtually zero a few years ago, are in the order of thousands of tons per year, and growing rapidly.

ATO research approach

ATO-DLO is actively involved with the development of various types of bioplastics. The strategy in this development has been the following.

First, it is important to approach biopolymers as polymers, for which polymer scientific and technological knowledge can be applied. So far, most knowledge has been developed for food applications, rather than for plastic production. However, when polymer technology is applied, three unique aspects have to be considered, which are the strong and unique molecular structure formation in biopolymer materials, the strong interactions between the biopolymers (H-bridges), and the fact that water is often a plasticizer. These three aspects lead to unique properties, such as a very different relationship between molecular weight and mechanical properties compared to most synthetic plastics. Furthermore, it is important that for a succesful development of bioplastics, molecular-oriented research is combined with processing-oriented research, since processing directly determines molecular structures, and therefore the mechanical properties of the bioplastics.

OPPORTUNITIES FOR BIOPOLYMERS

Good opportunities for bioplastics exist in the traditional field of bulk plastics. Due to increased scientific and technical knowledge of biopolymers, they also appear very promising for non-plastics, and as specific components in end-applications.

Bulk plastics

The perspectives for creating a significant market share for bioplastics are good. It is important, however, to keep three aspects in mind.

1. New bioplastics should not be introduced as a new raw material which can replace another (synthetic) material, but as a new material which can replace existing materials *in specific applications*. Some products made of HDPE can be well replaced by bioplastics, while others can't. The same applies for PS and PP products. This means that marketing efforts should be focused on specific products, rather than on introducing a new material to the whole plastic industry.
2. Market introduction and technical development should be closely related. Since the properties can vary widely, initial processing by end-users often fails, and material properties need to be altered. Only after cycles of optimization together with end-users, successful materials and products have come to the market so far.
3. The quickest market success can be obtained when there is a specific advantage of the bioplastic other than reducing the general solid waste problem,. Advantages can be edibility, anti-static behaviour, and compostability. Present products illustrate this, such as the gutter plug which is used in slaughter houses (improvement of hygiene, product based on PARAGON starch plastic made by AVEBE), compostable garbage bags for bio-bins (reduction of bio-binsmell), clay pigeons (present materials are toxic), and dog bones (edible).

Non-plastics

While most research has been focused on disposable plastics, other polymer applications are equally interesting. Biopolymers can serve well due to their versatile properties combined with their biodegradability. Examples of possibilities for development are listed in Table 1.

Tab. 1. Opportunities for biopolymers in non-plastics

Application	Advantage
super-absorbents	possibility for compostable diapers
glues	easier product recycling
paper coatings	improved paper recycling
packaging foams	no recycling costs
coatings	slow release of fertilizers, pesticides

All these applications are now feasible due to increased knowledge of biopolymer materials.

Components

Using biopolymers as one of the components in an end-product has many advantages. It means that no new product has to be introduced into the market, which requires much effort, both in terms of marketing and technology. In addition, when biopolymers are used as a component, the focus can be on replacement of toxic or expensive components of an existing product only. Examples of possibilities for development are listed in Table 2.

Tab. 2. Opportunities for biopolymers as components

Application	Advantage
agro-fibres (hemp, flax) in composites	improved recycling
surfactants in detergent formulations	biodegradability
super absorbents in diapers	compostable diapers
functional fillers in polymers	price reduction
laminate layers (e.g. replacement PVC or PVA as oxygen barrier layer in PE-foils)	price reduction/improved recycling
polymeric colorants	low toxicity

CONLUSIONS

Bioplastics have been traditionally developed as a bulk plastics with the aim of reducing solid waste. The market for these bioplastics is growing strongly. Interestingly, for many applications which are successful, bioplastics are used due to advantages other than their potential to reduce solid waste. Besides disposable plastics, recent knowledge has created new opportunities for biopolymers in the non-plastic field, and as specific components in (synthetic) products.