

Economics and environmental advantages of biodegradable polymers for food packages

Urs J. Hänggi, Biomer, Packtech meeting, September 3, 2004 in Gent

As this conference is organized within a Packtech meeting I have allowed myself to not to talk on "Economics and environmental advantages of biodegradable polymers" in general as announced in the agenda but to be specific and to present my personal view of the economics and environmental advantages of biodegradable polymers for food packages (slide 1).

Let me start with a provocative statement (slide 2): Food packaging is a commodity business. As such they are sold by price i.e. low prices play a decisive role. Biodegradable polymers are not commodity materials. Therefore they have no chances to enter the food packaging market.

I like to discuss first the price issue and then to dwell on the question "if prices prohibit market entry, what can we do to get a foot into this market anyhow?".

Cost arguments

Commodity plastics like polyethylene or polypropylene are byproducts of gasoline production. The low molecular weight fraction obtained during cracking crude oil consists of, among others, ethylene, propylene, butylene and styrene. If it were not for the plastics producers almost all of the fraction would have to be burned. Because burning is very, very expensive refineries are willing to sell the olefins to the plastics producers below actual costs. The take home lesson is that as long as cars run on gasoline or diesel, the raw material costs for commodity plastics remain low. Alternatives, including bioplastics have no chance. This situation will remain for quite a while.

Just to illustrate of what I am talking I will show 3 slides compiled by Dr. Demeter of BASF. Of the over 500 million tons of oil consumed in Western Europe 7% end up in plastics (slide 3). The amount of plastics going into packages is around 14 million tons per year (slide 4). Only less than 0,1 % or less than 14'000 tons is used as biodegradable plastics.

It is fair to say that this number still is exaggerated. A simple look at raw material prices explains why (slide 5). Processors pay less than € 1/kg for commodity plastics. Biomer now has to charge about 12 €/kg of PHB. Before increasing production this number was twice as high. 12 € is about 15 times the price of PE. No processor will accept such an increase except for unique, single shot marketing purposes. Even using the PLLA prices of Cargill Dow which we consider subsidized by the company the ratio still is 2 to 1. Thus it is not surprising to see that biodegradable plastics practically play no role in the packaging market.

Opportunities

Fortunately the situation does not look as grim as it might appear. Non-commodity or functional plastics such as PC or PA or PET (slide 6) also are 2 to 5 times more expensive than commodity plastics. Nevertheless such functional plastics are used in food packages if barrier or other specific properties are essential. Since PHB has better oxygen barrier properties than commodity plastics (slide 7) it has a chance to become an interesting material, even if the material price is high.

The next slide shows that such biomaterials exist. If you compare the data of Biomer®P226 with PP or Biomer®P240 with PE-HD you will see almost complete overlap in key mechanical properties. However the PHB formulations have additional benefits that interests both food and food package producers (slide 8): while being equal to PP or PE-HD Biomer resins also are fully biodegradable, allow to mold thinner walls or more complex structure, are more creep resistant, and have interesting barrier properties. Sample requests show that food industry is interested such materials.

Interference

Although this looks promising there is a caveat. Intuitively everybody accepts that recycling of food packaging by composting makes sense and that it would be worth doing so despite price differences. Product manager of food

processors and managers of retail chains concur. But they, in addition, also have to answer the question if the higher costs are reimbursed by their customers. Increased prices are accepted if the customer is convinced that the difference is worth paying for. Experience has shown that higher prices are accepted for "bio" or organic food. Organic food is associated with personal health worth, an item worth paying for. Biopackages produced from renewable resources offer no such personal advantage. Thus food processors and retail chainers have to accept that higher prices for biopackages are not reimbursed (slide 9).

Labeling a package "biodegradable" might be different. Waste disposal is cumbersome and costly. So selling a yogurt in biobased cups with a label (slide 10): "spoon it up and dispose of with the kitchen waste" certainly is appealing. However this might work in remote rural areas only. In populated areas with established waste collection systems the situation is different. Kitchen waste collectors will do everything to not to have to accept "plastics" in their collection. They fear that misdisposal might burden them of finally have to separate and to dispose of plastics parts in their collection. Today misdisposal of plastic parts in kitchen waste is rare. This is expected to change if biodegradable plastic food packages were introduced on a large scale. Even if there were no misdisposal with nondegradable plastics, composters still fear that some bioplastics parts that look like plastics will remain in the final compost. Such a compost no longer can be sold.

The new standards for biodegradable plastics take care of these fears. Even so, discussions still reveal opposition of almost all of the persons involved. Even if they were ready to accept the rational arguments of the standards they emotionally switch to killing arguments like "can you guarantee?" Of course nobody can guarantee that there is no misplacement or that no plastic looking parts don't end up in the final compost. Thus the selling argument "biodegradable" also leads a dead end (slide 11). Food processors and food packaging producers are forced to accept this. It might be that attitudes will change with time. However I fear that this will take up to 1 to 2 generations. Since a change of attitude is vital, I would like to discuss this market entry hindrance with you to explore possible ways to turn the opinion of waste treatment managers.

There is yet another barrier to the use of bioplastics in food packages, especially of bioplastics like PHB produced by microorganism. I keep pleading for a change of this barrier like Cato in Rome with his "cetera censeo....". Any material coming into contact with food has to be cleared by authorities to be safe for food contact. Unfortunately the present evaluating system is, as I have presented in the meeting in Copenhagen, inadequate for judging biosynthesized polymers. The evaluation is based on the toxicity of monomers and oligomers that possibly remain in as traces in the polymer and might diffuse into the food (slide 12). No biosynthesized plastic ever has monomers in it. So authorities have no base to rule. For this they ask that all potential contaminants are evaluated. This is extremely costly compared to evaluating single monomers in conventional plastics. I pledge that evaluation should be based on the bacterial strain and should state maximal limits for specific contaminant known to possibly being toxic such as metal ions or specific proteins. If a microorganism is known to be nontoxic and does not harm humans, animals, or plants, i.e. being a GRAS organism, then only the above mentioned maximal limit requirements have to be met. If the Packtech project is able to push discussions among the authorities into such a direction, the largest hurdle for bioplastics in food packages would be abolished.

Conclusions

Let me conclude this rather sober analysis of the chances for biobased food packages (slide 13). As biobased plastics can not compete in price with conventional plastics for the next 20-30 years they can not enter the market for mass products. However they have rather good chances in niche markets where specific properties like barrier characteristics are required. The "bio" argument is a theoretical one. Customers will not pay for the extra costs. The "biodegradable" argument is attractive, but fails in the waste collection and treatment systems. So if biobased food packages are to make it on the basis "biodegradable" then waste collectors and waste treatment managers have to be convinced that they don't "have to accept" but rather see a profit in getting biobased material. Then the "spoon it up and dispose of with the kitchen waste"

will win. Unfortunately I have little access to biowaste managers and no idea on how to change emotional attitudes. Anybody any suggestion?