# Pilot Scale Field Test for Compostable Packaging Materials in the City of Kassel, Germany

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## Abstract

Biodegradable (compostable) packaging materials made from biopolymers (BP) are introduced into the market to reduce the amounts of conventional packaging materials and at the same time be recovered by the municipal organic waste collection system. The processing of this organic waste mixed with biopolymers has been tested in a commercial treatment facility. The safe use of the compost produced from these materials was demonstrated in a full-scale agricultural application test.

KEYWORDS: model project Kassel, biodegradable polymer packing

## Introduction

Biologically degradable polymers (BP) have been developed in the last few years to be ready for practical utilization as a result of intensive sponsorship, as well as scientific and commercial research efforts. The application of biodegradable materials for packaging purposes was considered to be the most practical area for their use. Biologically degradable polymers based on renewable resources are considered in the German Packaging Ordinance [Verpackungsverordung, VerpackV, 1998], in the Biowaste Composting Ordinance [Bioabfallverordnung, BioAbfV, 1998] and it is possible to carry out a biodegradability test according to a DIN standard [DIN V 54 900, 1998] to determine their compostability. A pilot experiment to introduce packaging made from biodegradable polymers into the market was carried out to demonstrate whether or not it is possible to label biodegradable packaging products plainly and in a recognizable manner and to motivate consumers to properly segregate these materials after use and place them into the municipal organic waste bin. The main objective of this project was to clarify if the concentration of impurities (such as PE, PET, and others) in the organic waste (“biowaste bin”) changes due to improper identification as a conventional packaging by consumers. The pilot experiment started in May 2001 with the sale of products in the retail trade in the City of Kassel, Germany. Once the products were introduced into the market, the materials were collected,

mixed with the organic waste and transported to a full-scale processing facility for composting. The finished compost was thoroughly evaluated to determine its quality. Furthermore, the compost thus produced was tested on an agricultural pilot scale application. The life cycle of a biopolymer packaging product and the interaction between agriculture, producer, user and waste management are shown in Figure 1. Biodegradable polymers were developed to close the materials cycle. A plant as starch producing corn is grown, the starch is processed to a raw biodegradable material and used to made a biodegradable product, a packing item. Products with biodegradable packing are sold to consumers via the retail trade and deposed after use by consumers in the adequate recovery system, here the separate organic waste collection. Source separated organics including biopolymeric packing are processed in a composting plant to a compost fertilizer that is applicable for agricultural purposes. Producer and seller of packing items are obliged to guarantee an adequate reuse or recycling for their packing products according the German law [VerpackV, 1998]. This obligation can be transferred to an external provider, in the case Kassel to the Interseroh AG thus meeting the requirements of the law. .

Initially, it was envisioned that the project would last for 10 months; however, the project was extended until the end of 2002. The test program included three main parts: communication with customers, market analysis and the investigation of potential waste management problems. The pilot-scale model project was made possible by a 50% sponsorship from the German Agency of Renewable Resources (FNR e.V.). The remaining 50% of the costs of the project were sponsored by producers of the raw material, processing industries and the retail trade. About 20 companies were involved in the project and actively supported it. Moreover, local and national retail traders (store chains) also participated in the model project.

**Aims and Objectives**

The pilot test was carried out in the City of Kassel, Germany. The City of Kassel has a population of approximately 200,000 inhabitants in about 100,000 households. Kassel was selected for the project for several reasons. Some of these reasons include: the socio-economic structure of the city; the existence of the “biowaste bin”, which covers around 60% of the households; the multitude of retail trade shops; and last but not least, the support of the authorities. The Hessian Ministry for Environment, Agriculture and Forests has approved the collection of biologically degradable packaging via the municipal organic waste collection service as a dual system according to the German Packaging Ordinance [VerpackV, 1998]. Biodegradable items sold during the test included: bags, trays, racks for fruits and vegetables, packaging

of diapers, dairy products, bakery and butcher's products, bin liners and compostable food ware/catering products as cups, plates and cutlery. Most of the packing items used in this pilot project were made of starch or starch blends. Cups made of poly lactic acid (PLA) were employed for dairy products. Following list provides information about type an materials of biodegradable packing items used [DIN CERTCO 2002]:

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| organic waste collection bags | 12% |
| films | 1% |
| food-Service articles | 6% |
| food packing | 27% |
| shopping | 54% |

Examples of these materials are shown in Figure 2. Before all of these products were introduced into the market, they had to pass a certification procedure according to a DIN standard [DIN V 54900, 1998] that demonstrated their biodegradability. All of the products were marked identically with the label shown in Figure 3. Biodegradable packaging products were checked in a multi-stage examination procedure, based on a complete chemical analysis of all ingredients concerning their biodegradability, the complete biodegradability in lab-scale testing apparatus and their compostability in a full-scale composting plant. The composts that were produced were checked according to their quality. The maximum degradable thickness and the scheduled contents of the packaging were evaluated by DIN CERTCO (the body responsible for the product certification in Germany).

The communication strategy was planned to meet the following requirements: the consumer should be aware of biodegradable packaging materials and a certain incentive for buying such products should be ensured. Another point was to communicate the proper sorting behavior of consumers, since it is common in Germany to sort packaging into a different storage container for a completely different collection system ("yellow bag"). It was strongly emphasized that this new product, due to its composition, had a predetermined way of recycling - the organic waste collection. Communication and market analyses took place during the entire 18-month period of the testing phase. Collection via the organic waste bin, the utilization of the organic wastes mixed with biopolymers in a commercial composting system, the quality of the composts and the application of the compost in an agricultural demonstration test were examined. The behavior of the citizens of Kassel with respect to sorting the materials was evaluated by conducting representative interviews and by conducting waste analysis campaigns on nearly a monthly basis. The amount and the composition of the organic wastes collected, biopolymers and the components that were im-

properly sorted were detected, thus allowing the evaluation of the grading efficiency of the collection system “biowaste bin”. On the basis of these waste analysis campaigns, a simultaneous check on the size of the collection system (“biowaste bin”) was also carried out.

The evaluation of the size of the bin was carried out because it was originally assumed that there may be a demand for bigger bins due to the relatively low bulk density of biopolymers compared to that of organic waste. The determination of the waste composition of MSW, organic waste and the packaging waste was conducted using the method of collecting random samples [LfUG, 1998] in three different, representative urban area structures (AS) of the city. Three types of structures were chosen because it has been demonstrated that the waste yield depends on the area of the structures: AS 2 - multi-story with more than 3 floors or more than 6 apartments, AS 3 - multi-family dwellings with up to 3 floors or maximum 6 apartments and AS 4 - detached and two-family houses [Gallenkemper et al., 1997; Gallenkemper et al., 1998; Barghoorn et al. 1986]. These areas were selected to examine three different urban structures, thus obtaining representative data of different structures that could be extrapolated to gain information about the entire City of Kassel [INTECUS, 1994].

The second emphasis of the field test included the examination of the treatment procedure of biopolymer packaging in a full-scale composting facility. The main part of the investigation was the complete evaluation of the existing treatment system, the process technology’s capability to remove the impurities and the technical components concerning the processing of biopolymer packaging materials with the source separated municipal organic waste. The amount of impurities in the input stream introduced by improper sorting was evaluated by investigations at different points in time. High quality compost was found to be free of impurities and it met the standards of the German Federal Compost Quality Assurance Organization (Bundesgütegemeinschaft Kompost e.V.) [BGK, 1994] and RAL-GZ 251. The quality of the composts made from organic waste mixed with biopolymers was continuously monitored during the model test at a two-week interval according to the standards given in the German RAL-GZ 251 and in other federal law standards [BioAbfV, 1998]. The mature compost produced in the plant was evaluated three months before the start of the project, in order to obtain base data to compare with the results of the examination during the pilot trial. The following parameters were analyzed: dry matter content, pH, organic matter content, rotting degree, mass of impurities, the degree of optical pollution, the concentration of zinc content as an indicator for heavy metal contamination and plant tolerance by using barley.

The third part of the experiment included an agricultural demonstration test (Fig 4). The main objective of this portion of the experiment was to demonstrate that the compost was tolerated by plants, that the crop yields did not change and that the quality of the plants remained unchanged. The suitability of compost made from organic waste mixed with 1 % (w/w) of biopolymers as a fertilizer for plants was examined in this application test. The fertilizing effects of this compost were compared with those of conventional compost and inorganic fertilizer. The amounts of compost applied corresponded to a quantity of 30 tons dry mass per hectare. That amount is the maximum permissible load under the German Biowaste Composting Ordinance [BioAbfV, 1998]. The tests were conducted from June to August 2001 using Chinese cabbage. To evaluate any possible change of the nutrients in the agricultural soil, examinations of chemical and physical characteristics of the soil were carried out before and during the tests. Parameters chosen to characterize the soil quality in terms of soil chemistry were: pH, salt content, carbon and nitrogen contents, nutrients as P, K, Mg, Ca and heavy metals according the “Biowaste Ordinance”. To evaluate the physical soil quality, the pore volume and field capacity were also determined.

All tests were carried out four times in order to get statistically representative results [Schuster et al., 1979]. The following tests were carried out:: cultivation without the use of fertilizer, cultivation with inorganic fertilizer, cultivation with compost produced without biopolymers and cultivation with compost produced with biopolymers. The amount of compost used as fertilizer was calculated according to the German standard “Biowaste Ordinance” (BioAbfV, 1998). The following parameters were measured thus evaluating the effects of different fertilizers on the plants: the amount of the total and the marketable yield, fresh and dry matter of the plants, nitrate and vitamin C content. To determine the quality, the strength of the plants and the results of the self-decomposing test were compared.