Popular Science Summary

Composites composed of biodegradable polymer as matrix and natural fillers as reinforcement have attracted great attention in environmental protection. Biodegradable plastics are relatively easily degradable and their biodegradation takes from several months to several years (depending on material and degradation conditions). Bioplastics are biodegradable according to European Union standards (EN 13432) and can be organically recycled in compost. In particular, PHA vegetable fibres or grain composites may be used in horticulture as bio-based low-cost plastic crop containers designed to provide the same function as traditional plastic containers; then they biodegrade harmlessly into the soil after application. For food packaging applications, in which the container is to be degraded in the same stream as the food product, such composites can be used as packaging for fresh fruit and vegetables. Moreover, packages from bioplastics can be composted in a household. According to respective EU directives the amount of biodegradable municipal waste in landfills must be reduced. Thus, compostable plastics ensure environmental sustainability, because they are mostly manufactured from renewable raw materials, which lead to reduction of the use of non-renewable petrochemical materials. The addition of natural fillers to the compositions with the biodegradable polymers aims to improve the properties of the materials, as well as lower the prices. Active packages which possess some amount of antimicrobial additives belong to a very attractive alternative in the packages development. Insertion of bacteriocins directly into food by dispersing or mixing may induce negative interactions or dilution. Presence of antimicrobial additives in packages may cause the maintaining of higher concentration on the food surface, where the microbial growth is observed. The addition of antimicrobial agent to the composites may increase an interest in that kind of material in the field of active packaging, but also may introduce some uncertainty about its biodegradability.

The behavior of the biodegradable bioactive composites in the time of organic recycling is significant for their potential applications. In order to properly design the composite as a packaging material or in the form of disposable vessels, it is necessary to know the degradation kinetics. Significant impact on the rate of degradation may be caused by the types of fillers, their content and the presence of bacteriocins in the composites. The project is expected to examine the biodegradation both in industrial and laboratory composting conditions. The purpose of the project is to determine the effect of the natural fillers and bacteriocins content in selected composites, on the process of degradation, in particular under industrial composting conditions. Processing of composites will be carried out in micro-extruder Minilab. The bone-shapes bars ISO 527-2 (1BA) will be formed in MiniJet piston injection molding system. Samples will be tensile tested using tensile testing machine Instron 4204, crosshead section rate 20mm/min. Prepared samples will be tested for antimicrobial activity against at least two representative microorganisms one Gram-positive and one Gram-negative, using the disc diffusion assay. This investigation will be conducted in the School of Biology, Chemistry and Forensic Science, University of Wolverhampton, UK. Biodegradation tests will be carried out under both industial and laboratory conditions. Micro - Oxymax respirometer will be used for simulation of intense aerobic composting process. Developed at the Center research methodology of degradation under industrial composting conditions enables for research in three different industrial composting systems, both in naturally aerated compost pile, the KNEER containers system and BIODEGMA system. This methodology will be used in the project to evaluate the degradation progress in the organic recycling conditions. In parallel, the obtained polymer materials will be subject to hydrolytic degradation under laboratory condition. The study of structure of low molecular mass products of hydrolytic degradation using mass spectrometry will be performed. Changes in thermal properties during degradation will be evaluated.

To our best knowledge, the influence of the natural fillers and bacteriocins content in selected composites in which the matrix is an aliphatic biopolyesters, on the biodegradation process is so far unclear, especially under industrial composting conditions. The subject of the work will affect the development of science in the selection of natural fillers and design of appropriate composites with a wide range of applications especially in the field of active packaging. Another promising direction of the use of biodegradable composites seems to be to protect the environment. Products made from biodegradable materials after using are susceptible on organic recycling, which reduces the environmental impact of waste packaging and allows for the rational utilization of these materials under composting conditions in accordance with new trends in the management of this type of waste. However, the efficient their use requires basic research necessary to determine the relationship between the properties of such composites and the content, type of the natural fillers and presence of bacteriocins. Such studies are necessary especially in view of the fact that assimilation of low molecular mass degradation products is required.