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ANALYSIS OF MODERN BIOLOGICAL METHODS OF PLASTIC DESTRUCTION AND PROSPECTS FOR THEIR USING

Plastic is a broad name given to different polymers with high molecular weight, which can be degraded by various processes. However, considering their abundance in the environment and their specificity in attacking plastics, biodegradation of plastics by microorganisms and enzymes seems to be the most effective process. When plastics are used as substrates for microorganisms, evaluation of their biodegradability should not only be based on their chemical structure, but also on their physical properties (melting point, glass transition temperature, crystallinity, storage modulus etc.). Today, the prospects of different methods use for biodegradation of plastic are investigated in different countries of the world, namely:

- degradation by fungus Aspergillus tubingensis. This fungus secretes enzymes, which are destructive for chemical bonds in polymers. That is, it feeds on plastic in the same way as other living organisms feed on substances of plant and animal origin. The rate of decomposition of plastic under the action of the fungus is influenced by temperature and acid-base balance. (Temperature and acid-base balance infuelnce on the rate of decomposition of plastic under the action of the fungus). [1]

- using a thermophilic bacterium Brevibaccillus borstelensis strain 707 (isolated from soil) utilized branched low density polyethylene as the sole carbon source and degraded it. Incubation of polyethylene with B. borstelensis (30 days, 50°C) reduced its gravimetric and molecular weights by 11 and 30% respectively. Maximal biodegradation was obtained in combination with photo oxidation, which showed that carbonyl residues formed by photo oxidation play a role in biodegradation. Biodegradation of plastic is accelerated using mannitol and potassium nitrate.

Table 1. Effect of mannitol and potassium nitrate concentration on the biodegradation of (u.v. irradiated, for 60 h) polyethylene (LDPEL0235) by Brevibacillus borstelensis strain 707 after 30 days of incubation at 50°C [2]

Nutrient composition	Mannitol* (%)	KNO_3* (%)	Dry weight loss of polyethylene ± (%)**
Complete medium (control)	100	100	6.2 ± 1.2
Carbon limitation	50	100	5.7 ± 0.1
	20	100	6.8 ± 0.4
	0	100	11.0 ± 1.1
Nitrogen limitation	100	50	8·0 ± 0.6
	100	20	9.7 ± 0.7
	100	0	7.2 ± 0.1
Carbon and nitrogen limitation	50	50	6.9 ± 0.4
	20	20	6.8 ± 0.7
	0	0	7.9 ± 0.7

*Maximal concentrations (100%) of mannitol and potassium nitrate in VB medium were 5 and 2 g l^{-1} respectively.

**Experimentally obtained values minus values for noninoculated control, which were normally <0.2%, are given (n = 3);

- a method with the use of intestinal bacteria from moth larvae (Bacillus and Enterobacter), which intensively reproduce on polyethylene as a single source of carbon. These species caused polyethylene degradation after 28 days of their incubation on small sheets of the material: their tensile strength dropped by 50%, and their ability to repel water droplets fell by 30%. And after the microbes grew on the polyethylene for 60 days, the mass of the plastic films decreased by 10%, and the molecular weights of the polymer chains dropped by 13%; [3]

- the use of Plodia interpunctella larvae. Two bacterial strains capable of degrading PE were isolated from this worm's gut, Enterobacter asburiae YT1 and Bacillus sp. YP1. Over a 28-day incubation period of the two strains on PE films, viable biofilms formed, and the PE films' hydrophobicity decreased. Obvious damage, including pits and cavities (0.3–0.4 μm in depth); [4]

- the use of wax moth larvae. In tests, was found that about 100 wax moth larvae can eat about 92 milligrams of a normal grocery bag in twelve hours. Under optimal conditions and at temperatures around 30 degrees Celsius, bacteria can successfully degrade polyethylene terephthalate (PET). [5]

Biodegradable plastic is an innovative means of solving the plastic disposal problem from the standpoint of development of new materials. Today, the use of fungus Aspergillus tubingensis is the most interesting and poorly investigated method of biodegradation. This fungus is present in small quantities in rotten vegetables and fruits, and polyethylene can be used as an additional source of carbon. Aspergillus tubingensis does not form harmful substances in the process of decomposition; it is not harmful to flora, fauna and humans, which opens the prospect of further research.

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