Section I BIOMEDICAL ENGINEERING
Секція БІОМЕДИЧНА ІНЖЕНЕРІЯ

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USE MICROORGANISMS FOR PLACTISC PROCESSING

Annotation. Plastics are plainly superior accoutrements in terms of their costs, process capability and functional parcels. Mortal lives starts with the use of plastics and further and further plastics are being employed on diurnal base. Since polymeric accoutrements don't putrefy fluently, considering their cornucopia in the terrain, accumulation of plastics in tip and ocean has been adding from decades. Utmost of the plastics waste enters into water which is consumed by ocean brutes destroy their niche.

A small quantum of plastic is presently reclaimed, substantially by sorting usable types of plastic, melting it andre-curing it into bullets, which will be converted into lower- end plastics, similar as bags and artificial timber. According to a 2017 study by Wisdom Advances, in 2014 only 19 of all plastics were reclaimed. At the same time, by 2050, plastic product is anticipated to grow by 70 to nearly 600 million tons per time.

Keywords: biodegradable plastics, hydrolysis disorders, microorganisms synthetic plastics, natural plastics, enzymes.

The global plastics request continues to grow due to its physical parcels and advantages similar as low specific weight, reduction of the mass bit of food waste under the conditions of plastic use, continuity and cost. After using the plastic, it should be separated from the rest of the waste to be subordinated to the most effective recycling processes. It becomes more complicated.

Conventional processing styles lead to environmental pollution by release CO_2 or plastic remainders that fall into conduits and the ocean, where they persist and come poisonous to the entire food chain. For sustainable natural declination of fusions of exposed and non-exposed plastics recyclable, new biotechnological bones should be used approaches [1].

To overcome the problem experimenters have delved about the biodegradation of plastics by the degradable enzymes. Biological declination of plastics is fairly new conception appertained to the conversion of large polymeric motes into simpler bones by the action of biologically active enzymes produced by specific microorganisms which use them to fulfill their energy conditions [2]. Generally, the biodegradation of organic composites into either carbon dioxide and water in the presence of oxygen (aerobic biodegradation) or carbon dioxide, water and methane in the absence of oxygen (anaerobic biodegradation) by living organisms [3], includes the catalytic exertion of microbial enzymes. In this environment, different organisms are demanded some of which are able of demeaning long polymers into their simple form and some are able of exercising simple monomers latterly releasing simple waste products while others have the capability to deteriorate the simple excreta [3].

The microorganisms involved in biodegradation process differ from each other in their mode of action and their optimal growth conditions in soil depending upon their parcels [3]. Heterotrophic microorganisms can effectively populate plastics as their substrate [4]. Some important biodegrades of plastics are given in the Table 1.

Table 1

List of different microorganisms with their enzymatic ability to degrade polymers [4]

Bacteria	Enzymes	Plastics
Pseudomonas sp. E4	Alkane hydroxylase	LMWPE (Polyethylene)
P. Putida aj	Alkane hydroxylase	Vinyl chloride (polystyrene)
P. Chlororaphis	Polyurethanase	Polyester (pur)
P. Aeruginosa	Esterase	Polyester (pur)
P. Protegens bc2 12	Lipase	Polyester (pur)
P. Fluorescen	Protease	Polyester (pur)
Pseudomonas sp.	Lipase	PET
Pseudomonas sp. AKS2	Esterase	PES
P. Stutzeri	Peg dehydrogenase	Polyethylene glycol (peg)
P. Vesicularis pd	Esterase	Polyvinyl alcohol (pva)
R. Arrizus	Lipase	Pea, pbs, and pcl
P. Stutzeri	Serine hydrolase	Pha
Tremetes versicolor	Laccase	Nylon, PE
Rhodococcus equi	Aryl acylamidase	PUR
Brevibacillus borstelensis	Unknown	PE
Thermomonos pora fusca	Unknown	PVC

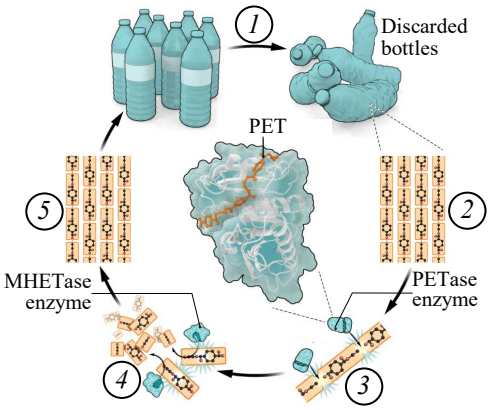

Fig. 1. Plastic schedule: *1* – A popular target for recycling is Polyethylene terephthalate (PET), a polymer in drink bottles and polyester clothing; *2* – PET consists of long strands made from monomers of ethylene glycol and terephthalic acid; *3* – Enzymes that digest PET include the bacterial enzyme PETase, which breaks the polymer'soxygen-carbon bonds; *4* – The result in gmonomers get broken into their constituents by asecond enzyme, MHETase; *5* – Those products, ethylene glycoland terephthalicacid, can be made into PET again with heat, pressure, and catalysts [5]

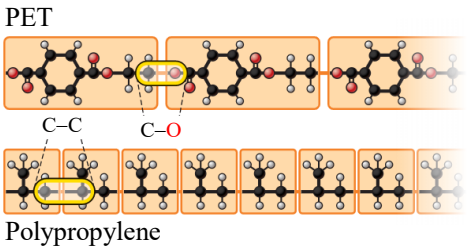

Fig. 2. PET is held together by bonds between carbon and oxygen, which require less energy tobreak in a chemical reactionthan those formed by links between two carbon atoms. Those bonds, found in many common plastics such as polyethylene and polypropylene, are harder to break [5]

Coming full circle. Scientists are engineering enzymes to recycle plastic. These modified versions of natural proteins work at relatively low temperatures, target specific plastics in a mixture, and produce pure monomers that can then form new plastic.

The process of biodegradation (Fig.1) takes place indeed in harsh conditions, if biosulfactants are used. Declination of different types of plastics requires different set of enzymes [6]. Utmost plastics are polyesters, whose biodegradation is generally catalyzed by enzymes similar as cutinase or esterases. There's also a protease, the target patch of which there are polylactides (PLA). The process of declination of the long polymer chain PLA (Fig. 2) first carried out using depolymerase. In the future, similar serine proteases similar as protease K and trypsin, degrade it further to low molecular weight composites (6). All of the below proteases that destroy PLA are available the results of the life of directors of microorganisms, similar as Amycolatopsis, Saccharothrix, Pseudonocardia and others.

It should be noted that these proteases are involved only in the declination of PLA. The vast maturity of enzymes able of putrefying several types of plastics. For illustration, cutinase is carried out declination of similar plastics as polylactide (PLA), polycaprolactone (PCL), polyethylene terephthalate known as PET and others. And lipases are able of biodegradation PCL, PLA, PBS (polybutylene succinate), etc (Fig. 3).

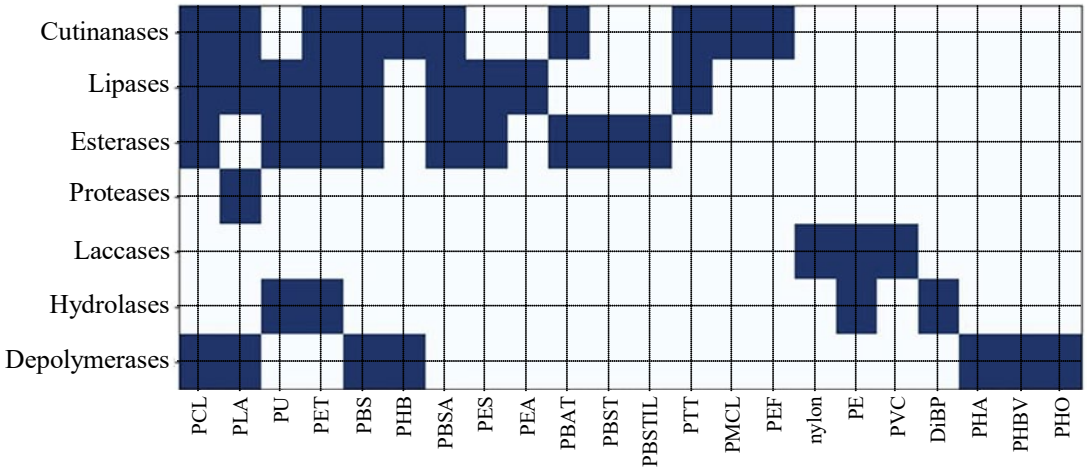

Fig. 3. Correlation between enzymes and plastics. Dark blocks indicate their interaction [7]

All the variety enzymes are involved in the biodegradation of plastics, while one type of plastic can be destroyed by various enzymes [7].

The set of microorganisms allows for the biodegradation of a wide range spectrum of plastics.

Aspergillus fumigatus, Pseudomonas fluorescens, Penicillium funiculosum capable of decomposing into simple compounds 10 or more types of plastics. Rhodococcus ruber, Comamonas acidovorans and Pseudomonas aeruginosa also demonstrate good biodegradability for more than five types of plastics. Plastics PE (polyethylene), PU (polyurethane) and PHB (polyhydroxybutyrate) can be biodegraded by more than 30 species of microorganisms. And the problem biodegradation of PLA and PCL can be solved with more than 20 species microorganisms [7].

Conclusion. Biodegradation is an effective system for plastic disposal. Exploitation of microbes for plastic declination is an ecological system. Different parcels of plastics affect its rate of natural declination. Weak forces (hydrogen bonds), covalent forces, affect the physical and chemical parcels of plastics and, therefore, affect the rate of declination. Because synthetic plastics are the most durable, there's a need to induce bioplastic accoutrements that will reduce the impact of plastics on the terrain. Microbial organisms convert plastic fusions into chemical factors that grease mineralization and composting of poisonous polymers and reduce the cost of product high value products.

Thus, the use of biodegradation of plastic is a promising way to solve such environmental problems as environmental pollution by plastic. Therefore, modern research in the field of ecology and biotechnology should be directed to the development of technological solutions for research and implementation of technologies for processing used plastic with the help of microorganisms.

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