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Microbiology in Environmental Engineering Science Along With Case Applications And Importance

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Abstract— ***One of the emerging fields of the science is Microbiology and it has been more useful day by day in many sides of daily life including many related topics of Environment and Human. Microbiology is fundamental side of Biology and now has many subdisciplines such as Bacteriology, Mycology, Protozoology, Virology, Evolutionary Microbiology, Nanomicrobiology etc. Microbiology has also wide range of applying sciences included Environmental Microbiology. Microorganisms or unseen organisms were hypothesized for many centuries before their actual discovery. Their life was postulated by many important scientists in history such as Mahavira, Avicenna… since 6th century. Today bioremediation, biotechnology, biogenetic studies are useful for quality life in terms of protection the Earth, supply food, water and environment for ecosystem. The main aim of the study is to show importance of environmental microbiology, applications, its trends and existing situation with a case solarization study. Effect of solarization was analyzed in sewage sludge in a wastewater treatment plant. Besides many applications and high technology examples were shown. Although today researches have nano scale technologies such as biotransformation, biodegradation and their standards, all these fields have originated from same fundamental basis. As result fundamental microbiology sciences and their principles are still vital for engineering and today technologies have to use and consider these sciences (Biology, Chemistry, Physics and Math) together and interdisciplinary.***

Keywords— Microbiology; Environment: Management: Applications; engineering applications.

I. INTRODUCTION

In recent years, the boundaries of knowledge of engineering sciences have been expanded by the progress in interdisciplinary fields. For example, bio-based components help different engineering sciences develop the broader field of applied sciences. Even 50 years ago, engineers had not considered incorporating microorganisms into these diverse processes [1, 2].

Firstly scientific focus of the environmental microbiology field was water quality and the fate of pathogens in the environment in the context of public health protection. Water quality had its roots in the early twentieth century when the purification of water supplies through filtration and disinfection resulted in a dramatic reduction in cases of typhoid and cholera [3].

Biological knowledge and sciences have many new processes, including microbes and bacteria. Using enzymes in refineries for biofuels and pharmaceutical products created for life improvements. The combustion of hydrogen does not generate any harmful air pollution. Even desulfurization does not require chemical solvents because microbes use sulfur gases, and sulfur can be removed from the natural gas stream. Traditional chemical engineering approach simple operation, while modern process engineers can only work with microbiological knowledge and applications [4]. Some of the modern products and their field were described in table 1.

TABLE I. SOME PRODUCTIONS OF MICROBIOLOGICAL PROCESSES

Field	Some Products
Energy	Ethanol, Methane, hydrogen (biogas)
Food	Dairy products, yeast, Beverages, Food additives Amino acids, Vitamins,
Pharmaceuticals	Antibiotic, Enzyme, inhibitors antibody, Steroid, Vaccine
Agriculturing	feeds, treatments, pesticides, inoculants
Chemicals	Ethanol, acetone, butanol, Organic acids
Biotechnology	Enzyme, Perfume, Polymer...

Today's world, the expansion of biological research mainly has been developing as microbiology field. Groundbreaking metabolic and genetic engineering in production and process. For example, applications of recombinant organisms in the medical and pharmaceutical sciences have successfully made cases of bioscience. In addition, knowledge of microbiology has created a new situation for the degradation of toxic organic compounds such as pesticides in the anaerobic process. In this new environment, organic chemicals will be converted into methane, hydrogen, and carbon dioxide and used as energy [5]. Enzymes, hormones or metabolite products of living organisms are used in many bioprocesses [6]. What we know about the microbial world that exists and affects every part of our lives and our applications in engineering are still limited today. The main aim of this study is to reveal how importance of the environmental microbiology along with its trends and existing situation of this field with a special case study.

II. Microbial Processes & Their Specific Environmental Applications

Many microorganisms (bacteria, virus, protozoa's) are considered an important pollutant as themselves. Institutes and agencies have certain policies to protection microorganism pollution with maximum concentration limits just as chemicals. Concentrated biological pollution can be observed in river, lake, swimming, recreational area, and treatment plants or in tap water. Microorganisms, their structure, occurrence, probability, health effects are quite complex situation. Some of the microorganisms (pollutants) are strong effective to ecosystem and human health such as E. Coli, Mycobacterium tuberculosis, influenza, herpes viruses, plasmodium, Legionella spp, Microcystis spp, Pseudomonas spp, iron and sulfur reducing bacterias) coming from mainly water [7-10], and these microorganisms can easily causing taste and odor problems. In addition, an exhaustive list of biothreats, weaponized pathogens [11-12] have been classified as possible dangerous contaminants.

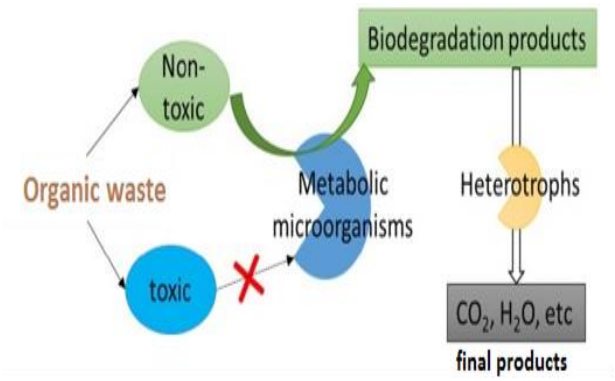

Fig. 1. *Metabolic pathways of pollutants degradation and transformation*

Microcystins (MC's) and cyanobacterias have special toxins and they are very common in environment. They cause especially unwanted taste and odour in drinking water. They need modern technological methods in the treatment plants because of their removal efficiencies are quite low in the conventional treatment plants and methods [13-14].

Mining is important in the field of Environment. Microorganisms are used safely for many treatment processes and bioremediation to remove organic pollutants. In biofilters, contaminants can be removed from air vapors through the filter media. A consortium of live microorganisms in the filter bed easily accomplishes the biodegradation of volatile organic compounds in a biofilter. Industrial applications of microbes in general: Raw materials; Organic pollutants (compounds) as substrates are Microbes/Biodegraded fine products. Most importantly, microorganisms are used to convert organic waste material into valuable and stable products [15-16].

Urban sewage pipelines transport domestic effluent to pump stations. Microbiological-induced concrete corrosion has been a problem with these pipes, leading to environmental pollution and road collapse. Increases the risk of spreading diseases such as Covid-19 where drainage systems are not well maintained [17].

Aquatic ecosystems, from small lake to ocean, have nondegradable micropollutants such as pharmaceuticals, new personal care products, hormones, oils, detergents, and disinfectants. This kind wastes have been increased each year. Thousands of tons micro plastics, hormones, polymer products have been used annually by human to prevent illness, disease and also as growth promoters in livestock and fish as well as agricultural industry. After new policies, their management strategies, detergents and pharmaceuticals could be direct remove from factories in its sources so that environment can be protected. This kind of pollutants were reported to be ubiquitously present in all aquatic ecosystem which related to human activities in different range. The biggest risk of this pollutants is because of their persistent and accumulative properties [18-20].

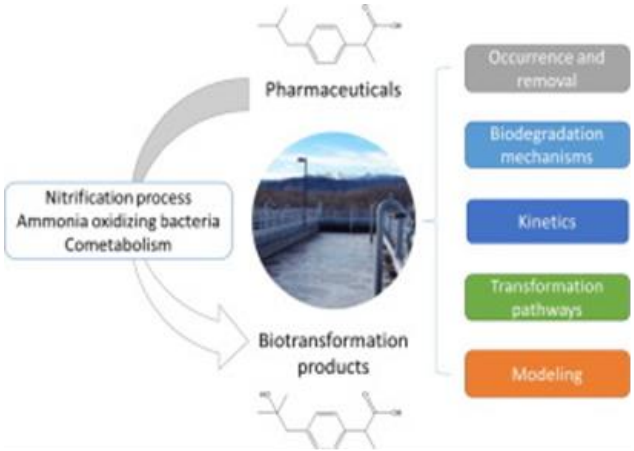

Fig. 2. *Biotransformation example in WWTPs process (20)*

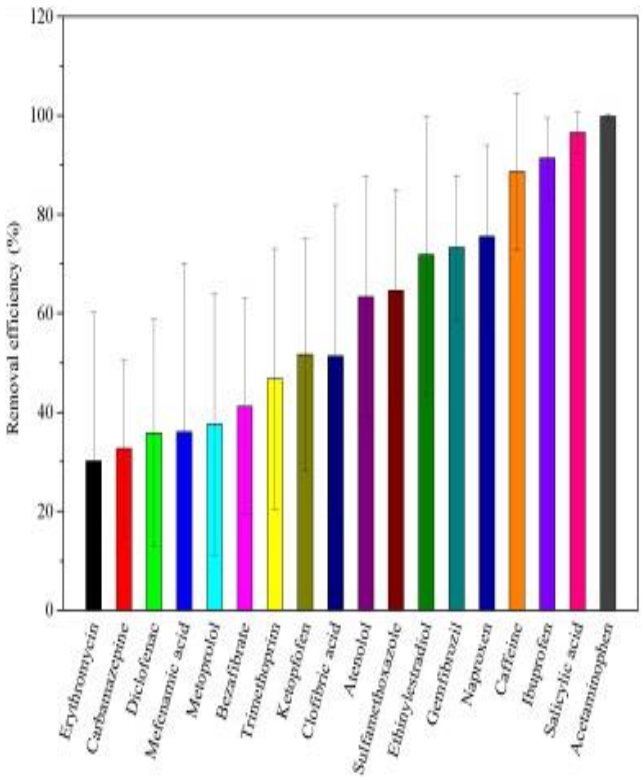

Fig. 3. *Efficiencies of some pharmaceuticals in WWTP (based on 21)*

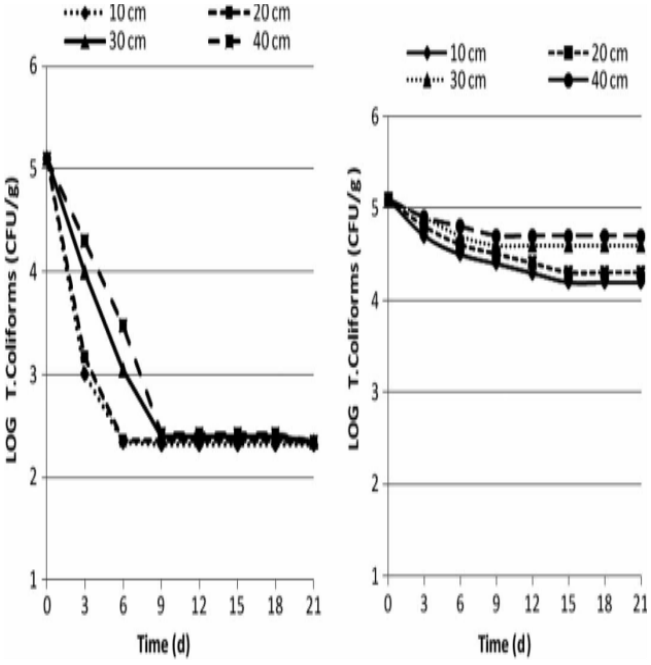

Fig. 4. *Disposal of the bacteria with solarization (a) and without solarization (b) in the sewage sludge depths (Ozdemir et al. 2014)*

Due to detergents, microplastics and pharmaceuticals have different physical and chemical properties, their disposal rate varied for wastewater treatment plants. In this case basicly classified as; degradation constant kbio: (i) compounds with kbio < 0.1 L g VSS− 1 d−1 are not removed to a significant extent (20%); (ii) kbio > 10 L g VSS−1 d−1 can be transformed by > 90%; and (iii) moderate biodegradable compounds (0.1 < kbio < 10) showed a partial removal [22] .

III. A CASE STUDY OF REMOVAL HARMFUL MICROORGANISMS VIA SOLARIZATION IN THE SEWAGE SLUDGE

Wastewater treatment plant located in Sakarya province-Turkey was chosen as the study area. Microbial monitoring of the treatment sludge obtained from here was carried out.

Direct solar effect is one of possible disposal method on unwanted microbial communities. To illustrate this one of the studies conducted about indicator microorganisms in Sewage sludge (thermotolerant coliforms, enterococci and Escherichia coli. Solarization quickly increases of the sludge temperature. Maximum sludge temperatures were achieved in the second week, 65, 58, 55 and 50◦C at different ten cm's depths from bottom to top layer 0–40 cm, respectively. Escherichia coli was found that the most sensitive microorganism and was disposed into under the detectable levels in 9 days of the experiment. T. coliforms were also fast inactivated but were not reduced under the detection limit in the solarization period [23].

As result, solarization one of the most effective methods to dispose sludge indicator microorganism during its digestion. They just need good management way with optimization which consider ambient air, temperature, and retention time.

With solarization, monitored bacteria were significantly removed; decrease was caused three orders of magnitude in all of sewage sludge depth. Statistical analyses indicated that declining of T. coliforms showed two significant inactivation curves with their tailings. Thermotolerant coliforms were more than 5 log g/DW when solar effect starting, then concentration was decreased to 2.3 log g/Dw in just a week (Figure 4). Layer was not observed as significant parameter. Between surface and bottom declining period had just 3 days different. Without solarization, declining of the selected microorganisms was very limited and simple.

IV. CONCLUSION

Microbiology, especially molecular and nanobiology fields are very important and promising for future. Its applications are very useful today and still need more attention and invest. Basic biology rules always will be used in studies just as years ago. Many microorganisms are useful in the environmental areas

and treatment on the other hand many microorganisms are harmful and need to be removed from our environment. It is seen that the microbial world, which is the interaction of the earth and living things at every moment, is used in many engineering fields today. Microbiology should increase in importance in construction, food, and many engineering applications, especially in the environment. Microorganisms should continue to be used positively in environmental engineering, especially in waste treatment. It has been seen that harmful microorganisms should be removed in water and the sludge body, as shown in our study.

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