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Short Communication

Plastic: An Immortal Incurable Commodity

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The advent of plastic has revolutionized human life in every aspect to the extent that today it can be found in every sector, every livelihood, educational institutes, medical equipment and also the International Space Stations (ISS). Such a demand has led to a global catastrophe, where around 12 million tonnes of plastic enter oceans annually. These plastics that erode away with time end as micro-plastics which are consumed by marine life, and ultimately end up in global food chain. Today its presence is observed from Arctic to Swiss mountains, from tap water to human feces. The scope and scale of damage happened due to the use of single-use plastic has become evident lately, which compelled the President of the UN General Assembly to include plastic pollution as a priority during the 73rd session in 2018. The discussion included efforts to help reduce the consumption of the plastic, increase awareness and to find global, regional and local solutions. World Health Organization (WHO) reports that around five hundred billion plastic bags are used each year, 17 million barrels of oil is used for plastic production each year, 1 million plastic bottles are bought every minute, 130 million tonnes leak into ocean every year, 1 hundred thousand marine animals are killed every year and 100 years of plastic is already accumulated in the environment waiting to be degraded. The scale of pollution runs so deep that today 10% of all the human generated waste is plastic waste, of which 50% of consumer plastics are single-use plastic, while 83% of tap water and 90% of bottled water is contaminated with microplastics [1]. In order to meet the supply and demand, it was observed that since 2004 to 2018, the world has produced as much plastic as it did in the previous half-century (8.3 billion tonnes of virgin plastics). It is mainly derived from crude oil, chemical feedstock, fuel sources or natural gas. The statistics from past few decades is shown in figure 1. In 2010, report says that around 9 million tonnes of plastic entered oceans solely due to mismanagement of the waste. Plastics account for around 10% of mass from the municipal waste and 85% of marine debris, most of which originated from the land sources [2].

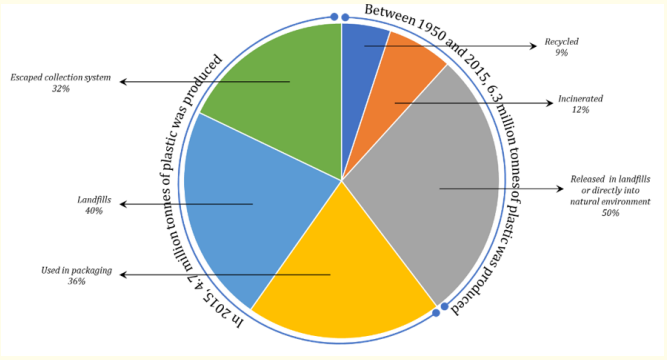

Figure 1: Statistics of the disposition of the materials made of synthetic plastic during past few decades.

Recent studies have also reported the impact of COVID-19 surge on the overall plastic pollution. The WHO declared COVID-19 as a pandemic in March, 2020. The pandemic which not only showed adverse effects on human health, world economy also resulted in a sudden surge in the demand of products made of single-use plastic which had a serious impact on management of the generated waste. Due to the significant increase in the demand of the personal protective equipment (PPE) kits- which is primarily plastic; masks, gloves, resulted in a huge medical plastic waste and seriously threatened the environment. Subsequent changes in the world order in transforming from offline to online, further increased the plastic demand in the form of packaging material that included medicines, groceries, online food, etc. [3].

There are numerous prokaryotes in nature that produce polyhydroxyalkanoates (PHA), which are biodegradable, renewable and a potential substitute to the current plastics in the market. Humans have started manufacturing products made of these biopolymers as it's relatively sustainable. The global market for PHAs which was estimated to be 62 million U.S. dollars in 2020 is expected to grow to 121 million U.S. dollars by 2025 due to an increase in the demand for the products made of biodegradable material. Further, policies laid by governments and strict regulations with proper implementation against single-use plastics might help solving the issue of plastic pollution. Microorganisms produce and accumulate these polymers as an intracellular granule; storage compounds. Few studies have also attributed the role of PHA to stress robustness of the microorganism. Bacteria produce these polymers usually in stressful or unfavorable conditions. Therefore, for the industrial scale production of PHAs, use of bacteria that is already accustomed to polluted environment or those belonging to the group of extremophiles would bring in a lot of benefits in the light of robustness in dealing with the extreme environment and also against contamination by other microflora which forms the basis of the concept of Next-Generation Industrial Biotechnology. Thus, the concepts such as synthetic biology and metabolic engineering would further elevate and improve the production of PHA by the extremophiles that can be sustainable and economical leading to the substitution of the massive market of petrochemically derived plastics with that of the products made of PHAs [4].

Biopolymers are also produced using inexpensive and renewable sources such as corn starch, straw, vegetable oils, sawdust, and others. Currently the products made of biopolymers represent only ~1% of the global plastic production volume, which is expected to grow as production becomes more sophisticated and diverse. As of 2020, 2.11 million metric tonnes of bioplastic production capacity were recorded globally, and it is expected to grow every year to reach up to 2.87 million metric tons by 2025.

In line with synthetic plastics, Asia is also leading in the manufacturing products made of bioplastics. Asia accounted around 55% of global bioplastic production in 2019, which is expected to remain above 50% until 2024. China leads the path in bioplastic industry with at least 15 companies working towards producing polybutylene adipate terephthalate (PBAT). It is used to make plastic bags that are biodegradable and are also high in demand. China BBCA group, a company in China, is confident of producing almost double the expected global demand volume of polylactic acid by 2023. Europe too, is poised to have production capacity to share and grow by ~10% between 2019 and 2024. It is the 2nd largest bioplastic producing region in the world [5]. However, Europe and other world region's share in overall bioplastic production is expected to decrease and Asia is predicted to cross the 70% production volume mark by the end of 2026 [6]. The current production volume of bioplastics by region is shown in figure 2.

Figure 2: Percentage global production capacities of bioplastics in 2021 (by region).

The process of biodegradation of some plastics occurs in specific environments such as high temperature like industrial scale composting facilities. Few disadvantages which the world

might face due to increase in demand for bioplastics is, an increase in deforestation as the this would require land to grow feedstocks for bioplastics. Based on the chemical structure and process of production, some bioplastics may also leach harmful chemicals. Though bioplastics seem to be less harmful and a convenient and potential contender as an alternate to current synthetic plastics in the market, it alone cannot be the final solution to the plastic pollution crisis. The continuous efforts towards reducing the synthetic plastic manufacturing and consumption must be carried-on on a global scale [5].

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