A NOBLE PROCESS OF PRODUCTION OF BIO PLASTIC (DEGRADABLE) FROM WASTE PLASTIC (NON- DEGRADABLE)

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Abstract:-Polyethylene terephthalate (PET) is extensively used in plastic products and its accumulation has become a source of pollution. A novel bacterium- Ideonellasakaiensis 201-F6, we have isolated due to its ability to use PET as its major energy and carbon source. Our aim is to use the plastic polymer to break into carbon atoms and which are further being used to prepare degradable Bio plastic. In plastic recycling, chemically-broken down PET is re-synthesized to make new PET. Therefore, it is possible to replace the breakdown process with a biological one to produce degradable plastic. We have used an environment which was rich in CO_2 and constant energy resources. The bacteria were being introduce then to the non-degradable plastics and after due course of time we got the bio degradable PET. This amount of PET and time can be varied by the amount of non degradable plastics and bacteria and also on the contents of the plastic products.

Key words: **PET, Ideonellasakaiensis 201-F6, Bio degradable, Bio plastics, carbon source**

1. Introduction:

Packaging waste forms a significant part of municipal solid waste and has caused increasing environmental concerns, resulting in a strengthening of various regulations aimed at reducing the amounts generated. Among other materials, a wide range of oil-based polymers is currently used in packaging applications. These are virtually all non-biodegradable, and some are difficult to recycle or reuse due to being complex composites having varying levels of contamination [1]. Plastics are carbon-based polymers that are long-chain molecules that repeat their structures over and over. Those are made mostly from petroleum and harmful to the agricultural activity and our immunological health. Burning them can give off toxic chemicals such as dioxins, while collecting and recycling them responsibly is also difficult, because there are many different kinds and each has to be recycled by a different process [2]. Polyethylene (PE) is a major contributor to waste plastics as the material is widely used in various packaging applications. In the agricultural sector, many discarded plastic materials consist of poly bags used for sowing seeds and mulch films used to cover the limits of sowing seedlings. Poly bags and mulch films commonly used are of low density polyethylene (LDPE), linear low density polyethylene (LLDPE) and high density polyethylene (HDPE).

Many different materials are used for packaging including metals, glass, wood, paper or pulp, plastics or combinations of more than one material as composites. Most of these enter municipal waste streams at the end of their service life. Over 67 million tonnes of packaging waste is generated annually in the EU, comprising about one-third of all municipal solid waste (MSW) [3]. Plastics contribute 18 per cent of the 10.4 million tonnes of packaging wastes produced annually in the UK (DEFRA 2007). Discarded packaging is also a very obvious source of litter, posing a major waste management challenge [4-9].

In recent years, the recycling of packaging materials has increased but the recycling rates for most plastic packaging remain [10-11]. A large number of different types of polymers, each of which may contain different processing additives such as fillers, colourants and plasticizers, are used for packaging applications [10,12-13]. These composition complexities together with contamination during use often render recycling uneconomic compared with disposal in landfill. Although the proportion of waste being landfilled has fallen in recent years, around 60 per cent of municipal waste in England still ends up in landfill [14]. This presents environmental concerns, resulting in strengthening of regulations on waste (e.g. Packaging and Packaging Waste Directive (94/62/EEC) and UK Packaging Regulations (1998).

Agricultural residues management is considered to be a vital strategy in order to accomplish resource conservation and to maintain the quality of the environment. In recent years, biofibers have attracted increasing interest due to their wide applications in food packaging and in the biomedical sciences. These eco-friendly polymers reduce rapidly and replace the usage of the petroleum-based synthetic polymers due to their safety, low production costs, and biodegradability [15]. Biodegradable plastics with functionalities and processabilities [16] comparable to traditional petrochemical-based plastic have been developed for packaging applications [17] Typically, these are made from renewable raw materials such as starch or cellulose. Interest in biodegradable plastic packaging arises primarily from their use of renewable raw materials (crops instead of crude oil) and end-of-life waste management by composting or anaerobic digestion to reduce land filling [18]. The disposal of packaging materials is particularly significant in view of the recent focus on waste generation and management as important environmental aspects of present-day society [19-20].

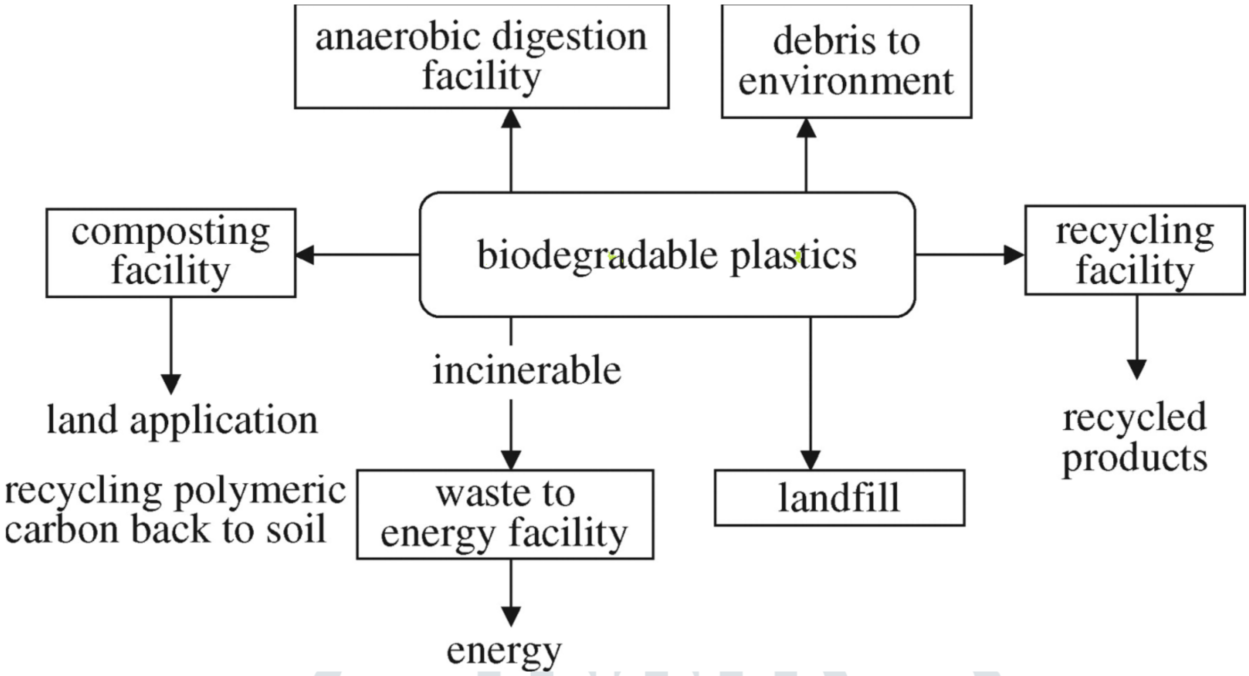

Fig:1: Showing the utility of Biodegradable plastics

When some biodegradable plastics decompose in landfills, they produce methane gas. This is a very powerful greenhouse gas that adds to the problem of global warming. Biodegradable plastics and bioplastics don't always readily decompose [20]. Some need exposure to UV (ultraviolet) light or relatively high temperatures and, in some conditions, can still take many years to break down. Even then, they may leave behind micro-fragments or toxic residues[21]. Bioplastics are made from plants such as corn and maize, so land that could be used to grow food for the world is being used to "grow plastic" instead. By 2014, almost a quarter of US grain production was expected to have been turned over to bio fuels and bio plastics production; taking more agricultural land out of production could cause a significant rise in food prices that would hit poorest people hardest . Growing crops to make bio plastics comes with the usual environmental impacts of intensive agriculture, including greenhouse emissions from the petroleum needed to fuel farm machinery, and water pollution caused by runoff from land where fertilizers are used in industrial quantities. In some cases, these indirect impacts from "growing" bio plastics are greater than if we simply made plastics from petroleum in the first place. Some bio plastics, such as PLA, are made from genetically modified corn. Some environmentalists consider GM (genetically modified) crops to be inherently harmful to the environment, though others disagree. The schematic diagram has shown the petroleum product to convert into the biodegradable product.

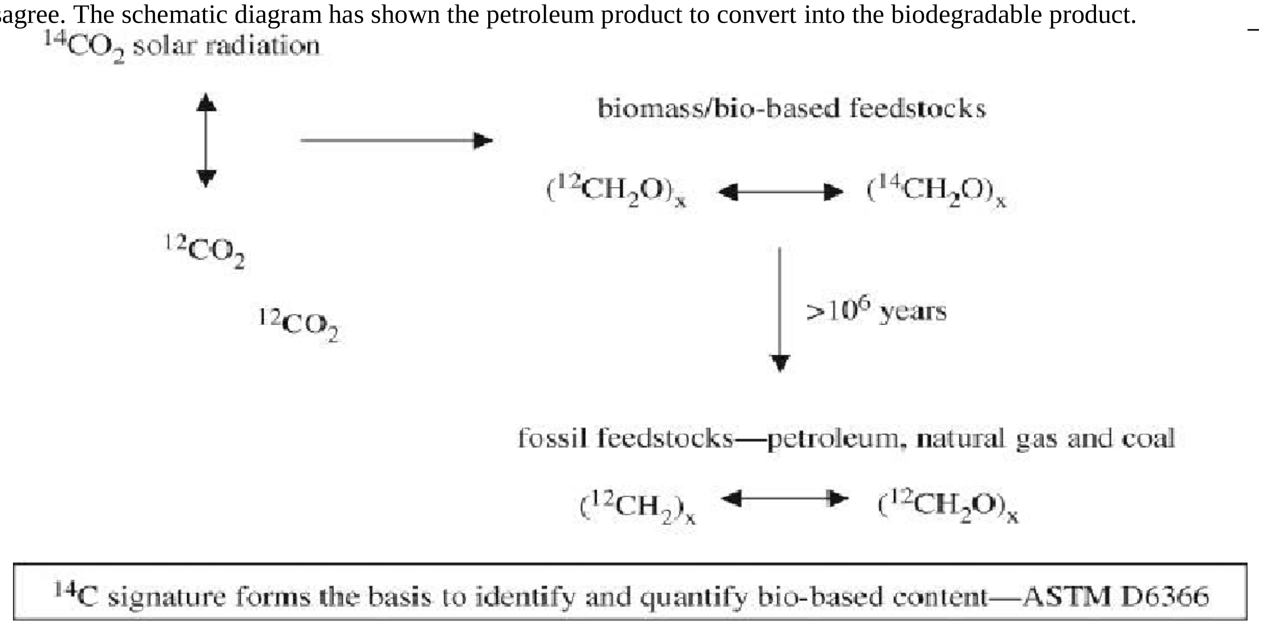

Fig:2: carbon-14 signature of bio and petrochemical polymers [ref:1]

The original *Ideonella sakaiensis* bacterium is far from the first living species to possess plastic-eating proclivities. Wax worm caterpillars have been found to break down plastic in a matter of hours, and mealworms possess gut microbes that eat through polystyrene [22].

Ideonella sakaiensis 201-F6 could digest the plastic used to make single-use drinks bottles, polyethylene terephthalate (PET) [23]. It works by secreting an enzyme (a type of protein that can speed up chemical reactions) known as PETase. This splits certain chemical bonds (esters) in PET, leaving smaller molecules that the bacteria can absorb, using the carbon in them as a food source.

Poly(ethylene terephthalate) (PET) is the most abundant polyester plastic manufactured in the world. Most applications that employ PET, such as single-use beverage bottles, clothing, packaging, and carpeting, employ crystalline PET, which is recalcitrant to catalytic or biological depolymerization due to the limited accessibility of the ester linkages. In an industrial context, PET can be depolymerized to its constituents via chemistries able to cleave ester bonds [24-25]. However, to date, few chemical recycling solutions have been deployed, given the high processing costs relative to the purchase of inexpensive virgin PET. This, in turn, results in reclaimed PET primarily being mechanically recycled, ultimately resulting in a loss of material properties, and hence intrinsic value. Given the recalcitrance of PET, the fraction of this plastic stream that is landfilled or makes its way to the environment is projected to persist for hundreds of years [26]

In this paper we have used these plastic eating bacteria to degrade the non degradable plastics to release the carbon and which is then being used as the carbon-source for the plants to produce the starch. We have used the potato plant to get more starch from a single unit and there are a various possibilities for growing the new plants higher in numbers.

2. Materials and Methods:

2.1. Microbial Culture:

Liquid agar media (LB)(Sigma Aldric) was prepared and the autoclaved and cool to room temperature and transfer approximately 1 mL of overnight *Ideonella sakaiensis* culture to the flask and incubated overnight in a shaker (REMI). Sterile plates are being made with LB media and transfer the bacteria and incubated for overnight to get maximum number of bacteria.

2.2. Bioreactor:

Bioreactor was made with two inlets for plastics and the microbes and one outlet for carbon to take out from it and channelize that outlet to the plant tissues culture lab. The flow diagram is shown in Fig.3.

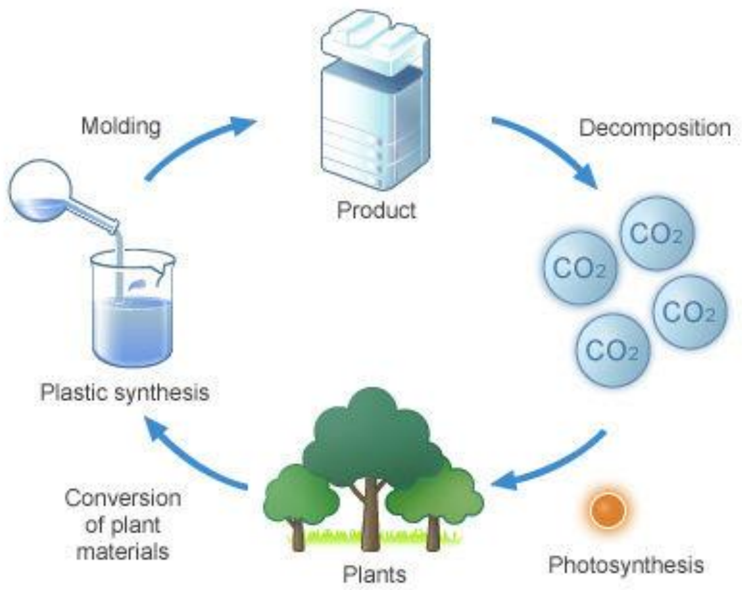

Fig: 3: schematic diagram for the whole experiment.

2.3. Plant tissue culture:

Potato plants have taken for getting the maximum amount of starch and higher growth rate. The standard MS media is used for the plan tissue culture and all phyto-hormones are provided by the media. The carbon which was produced from the bioreactor, was espoused to light and Oxygen that provides the carbon source for the plants.

3. Results and Discussion:

PLA was produced from plants which take in carbon dioxide and turn it into sugars which are stored as starch. The starch is then collected and processed to create dextrose which is then fermented with special bacteria to make lactic acid, the building block for PLA. In this way carbon dioxide is taken from the air and turned into valuable plastic. Of course, some energy is used in growing the plants and processing the starch, but it is intended that through improved efficiency and engineering the process will become carbon neutral or even a carbon sink in the future. Floreon is made by taking PLA and adding a special combination of other bioplastics at very low levels to boost performance and add value to this renewable material, taking its range of applications even further. If used for energy recovery post use these renewable materials will simply release the carbon dioxide sequestered by the plants back into the atmosphere in a ‘short carbon cycle’, unlike oil based plastics which release carbon that has been trapped underground as oil. At present, using PLA in place of oil-based PET results in 75% lower greenhouse gas emissions even if both end up in landfill. Floreon can be processed at much lower temperatures than other plastics such as PET, saving energy in the manufacture of finished goods. Bottles and food trays can also be moulded and thermoformed at much lower temperatures. The additives in Floreon lubricate the melt making the material easier to process relative to unmodified PLA, whilst also boosting performance.

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