Organic Waste to Bioplastics

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***Abstract*— High molecular mass synthetic polymers are the key component of plastic materials (plastics). Polymeric materials successfully penetrated the global market due to their cost-effectiveness and simple processing which made them elevate living standard and the quality and comfort of life. Petrochemical industry via fossil fuels provides the raw materials for synthesizing almost all available plastics today. Each one of us meets a wide range of plastic materials and products made from them daily, because polymeric materials, due to their amazing diversity, cover an unbelievably wide range of characteristics and applications. Different types of plastics are being used for wrapping edibles as well as personal hygiene products. Sports and lab equipment made from plastics, children's toys, automobile parts, stationery, computer hardware, kitchenware, etc. are just some of the uses of plastics.**

Due to the exceptional growth in the production and the use of polymers, consideration about the waste management of these products and the consequences of the plastic products use, is a current, burning and pressing issue. The prime focus of concern is the potential impact of artificial substances on human health and the damage which they cause to the environment. Exploitation of precious non-renewable resource fossil fuel materials for plastic production results in Global warming. In addition, part of the plastics finds its way into the natural environment, where they represent a permanent foreign body in the landfill, as they consist of artificially synthesized polymers which do not usually occur in nature. As such, they can represent a source of organic pollutant release into the environment, and the entering of the former into the food chain.

This paper is an attempt to make the plastics from discarded waste peelings of water chestnut (Singhara). In this way the organic waste is put to use to produce ever utility substance which is capable of degrading or decomposing in its life end.

Keywords*— Plastics, organic waste, water chestnut, sugar apple, degradation.

INTRODUCTION

Conventional plastics are made up of typical organic molecules formed by joining many, often thousands, low-molecular-weight monomers, containing some inorganic compounds, that are joined together by a process called "polymerization" Different kinds of polymers are fibers, films, elastomers (rubbers), and biopolymers (i.e., cellulose, proteins, and nucleic acids)etc. Plastics are made from precursors, organic materials, which are mostly derived from petroleum or petroleum based products, these plastics are partially natural, mostly derived from petrochemicals. The basic raw materials used to make them are fossil fuels such as mineral oil, natural gas, coal, and some other materials. (1)

Plastics are cheap, lightweight, strong, stiff and hard or flexible and soft, and can be moulded in any desirable and utilizable shape according to the requirement. These properties have made plastics to be used in making millions of items from balls in sports to bathtubs in house ware, spoons, refrigerators in household, cars to cabinets, packaging and so many more uses. In the modern times we cannot think our routine without the use of plastics in some form.

TYPES OF PLASTICS

A number of types of plastics are available which may be partially or completely synthetic. There are many basis on which plastics have been categorized. One such basis is response towards heat, the plastics which can be heated and moulded a number of times are thermoplastics and one which can be made into a particular shape only once are called thermosetting plastics which cannot be remoulded again and again on heating. These plastics thus cannot easily degrade also in the natural environment. The plastics which do not easily degrade can pose a problem in their end life.(2)

COMPOSITION OF PLASTICS

Natural polymers such as cellulose, wool, cotton, leather, etc. are known to us from ancient times. Man in the sequence of development has tried to imitate the nature to make artificial polymers like plastics, nylon, etc. Chemists with their ability to engineer, to yield desired set of properties like strength, density, transparency, heat resistance, corrosion resistance, abrasion proof, shatter proof ,ductility, malleability, electrical conductance, hygienic, etc. has greatly expanded the many roles these plastics played in the modern industrial economy.(3,4) These roles may include as packaging material (due to their cheap but strong, malleable, transparent, corrosion protectant nature), for roofing, flooring, insulating, or making doors, windows or in pipe fittings as construction and building material (as are durable and cost effective). Plastics also find use medical and health industry as plastics pill capsule, in hearing aids, in artificial corneas or as orthopaedic devices, where they align, support or correct deformities in a human body with lot more applications including acrylic paints, architectural raw material in making panels Greenhouses, etc.(6)

HEALTH AND ENVIRONMENTAL DANGERS OF PLASTICS

Since middle of the twentieth century, the ever increasing plastic production had saturate the world and posed a big threat to environment. BPA and phthalates is the chemical additive that not only prevents degrading of plastic structure, but they also interfere with our natural hormone levels which can cause serious problems in humans. The problem is grave in case of toddlers as most of the toys are made of plastics, which through the hands goes into the mouth of these kids, thus affect the metabolism of the individual. Plastic bags which are generally used as carry bags for fruits, vegetables, clothes and other purchase items; have a habit of flying everywhere as people don't discard them properly. Not only does this look horrific and untidy as it is occupying all the natural habitats from oceans to forests, rivers to grasslands, where they are just discarded without taking care that here a serious danger to birds, fishes and other land and aquatic animals that often mistake them for food. Thousands of the animals die after swallowing or choking on consuming discarded plastic bags each year and the worst about plastic bag is that they are not biodegradable. They clog water ways, spoil the landscape and may take 1000 years or more to break down in to small particles.

SUBSTITUTES FOR PLASTICS

One Survey report states that, if a common man, uses a cloth bag instead of a polybag, we can save 5 to 6 bags a week, 20 to 24 bags a month, 200 to 288 bags a year, and app. 22 thousand bags in an average life time. If just 1 out of 5 people in our country did this we would save 1,330,560,000,000 bags over our life time, the grave problem can at least be handled to an extent.(7)

But plastic's durability ,cost-effectiveness, strength, light weight quality ,long life, versatile use in almost all fields of life require a biodegradable safe material having exactly the same qualities as of plastics, as a an alternative or a replacement.

A thorough study of the composition of plastics found that if plastics are made of natural substances then there is a possibility of their degradation and also being as effective in performance as plastics. These polymers are known as bio plastics (made from natural substances like corn, sugarcane, sugar beet , cassava,etc.

BIOPLASTICS

Biobased plastics are manufactured from renewable raw materials. Biodegradable plastics (degradable; biodegradable; compostable) are manufactured from renewable or fossil raw materials, or they are blends (mixtures). A biobased plastic material (from renewable resources like natural oil) is not necessarily biodegradable. Biodegradability is a specific feature of some plastic materials or polymers that plastic materials are composed of; biological degradation or, shortened, biodegradation, denotes the process of degradation of the polymer material under the influence of biotic (living) factors. The process of biodegradation is based on the fact that organisms, mainly microorganisms (bacteria, fungi, and algae) identify the polymer as a source of organic building blocks (e.g. simple saccharides, amino acids, etc...) and source of energy they need for life. Simply put, biodegradable polymers represent food to the microorganisms.(10) The polymer chemically reacts under the influence of either cellular or extra-cellular enzymes, wherein the polymer chain is split. The process can take place under the influence of a variety of enzymes, and gradually leads to smaller molecules. The latter enter the metabolic processes that take place inside the cells (e.g. Krebs cycle) and alongside the emission of energy are converted into water, carbon dioxide, biomass and other basic products of the biological conversion. A characteristic of products of degradation is that they are not toxic and are quite commonly present in the natural environment as well as in living organisms. Artificial material (e.g. plastics) is in this way converted into elements, which are normally present in nature.(11,12) The process of conversion of organic carbon (in our case, the polymer), into inorganic carbon – e.g. carbon dioxide, is called mineralization. For biodegradability itself, it does not matter whether the polymer is made on the basis of renewable resources (biomass) or on the basis of non-renewable (fossil fuel) resources, but only what its final structure is. Biodegradable polymers can thus be made based on either renewable or non-renewable resources. It is very often wrongly assumed that all biodegradable polymers are made from renewable resources.

FRAGMENTATION + MINERALISATION = BIODEGRADATION

WATER CHESTNUT (Trapa bispinosa)

Water chestnut, commonly known as 'Paniphal', Trikona phalam (in Sanskrit) or 'Singhara' in Hindi in India is a vegetable that is native to Rajasthan, U.P, Madhya Pradesh,etc.. It is grown on marshes, ponds and seasonal and perennial lakes in many places in Pali, Udaipur, etc in Rajasthan. More than two-thirds of the plant remains submerged in the water. The upper leaves float on the surface of the water while the lower ones remain submerged just beneath the surface, giving a mat-like appearance to the water surface. The flowers open above the water surface. After pollination they submerge themselves so that the fruit can develop. Therefore, the fruit or singhara is always found hidden under the leaves, and when it gets mature, it automatically drops off on the ground which is the, fished out with the aid of a net.

NUTRITIONAL VALUE OF WATER CHESTNUT

Water Chestnut have excellent nutritional value especially for the people living in dry arid zones as it is a source of water along with nutrition, thus a complete food .In one hand it serves as food , but the peel which seems waste can suitably be taken up for conversion into a plastic which is degraded in nature.

Amount of Water Chestnut: 100g

Nutrient	Amount
Water	~48.0 g
Protein	~3.5 g
Fat	~0.2 g
Carbohydrates	~32.0 g
Sugars	~3.5 g
Energy	~730
Dietary Fiber	~15.0 g
Calcium	~18.0 mg
Zinc	~0.4 mg
Iron	~0.7 mg
Sodium	~1.0 mg
Potassium	~468 mg

MATERIALS AND METHOD

A. Treatment of Water Chestnut peels

Water Chestnut peels in fresh state (without drying) are ground with distilled water in approximately same ratio in a grinder. Then with the help of simple filter paper the solution is filtered. The greyish filtrate is decanted to get the greyish powder settled at the bottom. This powder is repeatedly washed with distilled water 2-3 times to extract powder completely from the grinded pulp. Further this powder is collected from the bottom of the container and dried completely in an oven. [4]

B. Preparation of bio plastic

The dried powder is mixed with ten times its weight of distilled water. This solution is then diluted, acidified, followed by adding glycerol and heating to 200-210ºC with continuous stirring. After heating with stirring, we get transparent and highly viscous mass, which ultimately turns into watery liquid. [5] The resultant solution is cooled slowly and made neutral by addition of NaOH. Finally this mass is spread evenly on aluminum foil to make bioplastic. [8][4] It takes some days to dry out completely. This prepared bioplastic now can be subjected to the different tests to check its spreading and degradation property.

RESULT AND DISCUSSION

The bioplastic (highly viscous mass) obtained from water chestnut peels just after preparation can be spread into very thin sheets. These sheets after drying were able to hold little less weight in comparison to potato peel plastic. The reason for this behavior of water chestnut peel bioplastic may be due to the presence of impurities, which are more in comparison to potato peel plastic.

A. Degradation Test

Paper sample, Water chestnut peel bioplastic and potato peel bioplastic is taken of same dimension, weighed separately and their weights were noted separately.[11] Both the samples were then buried under the soil at the same depth having same conditions of pH, temperature, humidity, organic matter, etc.[14] The results of the degradation tests are summarized in the table below. It is very clear from the test done that paper degrades within a week, but the same amount of WCPB and PPB takes longer, still degradation is very clearly observed. While observing the degradation in the peeled plastics, it was observed that PPB degrades faster than WCPB.(15)

Number of days	Observation for degradation			
	Wt. of Water chestnut peel bioplastic (WCPB)	Wt. of Potato peel bioplastic (PPB)	Wt. Of Paper	Observation
Day 1	8 gms.	8 gms.	8 gms.	No degradation
Day 3	7.2 gms.	6.3 gms.	5.4 gms.	Degradation starts
Day 5	6.7 gms.	5.8 gms.	3.2gms.	Paper degraded, PPB slowly degrading
Day7	5.2 gms.	4.9 gms.	2.0gms.	Rate of degradation slows down
Day 9	4.7 gms.	4.0 gms.	-	Degradation continues
Day 11	4.1 gms	3.4 gms.	-	Degradation continues
Day 13	3.5 gms.	2.9 gms.	-	Degradation continues
Day 15	2.8 gms.	2.0 gms.	-	Degradation continues
Under same conditions of soil, temperature and humidity				

Table: Comparison of degradation of WCPB,PPB and paper

DISCUSSION AND CONCLUSION

Bioplastics can thus be made from a waste organic material as seen here which can degrade at a comparable rate with other such plastics of the same type. They do not pose much problem of starving of the people as they are not prepared from any material which is edible or can serve as a life sustaining material for humans. Also it is solving the problem of waste disposal as by converting the waste of water chestnut into plastic one more problem is tackled successfully. As seen in the table above it degrades but takes longer time for degradation, most probably due to cellulosic base, which takes longer to disintegrate.

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