

BIODEGRADABLE ALTERNATIVES FOR PLASTICS – A CASE STUDY

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Abstract— Packaging waste forms a significant part of municipal solid waste and has caused increasing environmental concerns, resulting in tightening of regulations aimed at reducing the amount of waste generated. Among other material, a wide range of plastics are still used in packaging applications by producers from both organized and unorganized sectors and traders of various products even though it is being banned in a phased manner by the Indian Government. These are virtually non-biodegradable, and some are difficult to recycle or reuse due to being made of complex composites having varying levels of contamination. In our vicinity, such packaging material is observed to litter the environment in every nook and corner, around our residences, on the roads and everywhere. Recently, significant progress has been made in the development of biodegradable plastics, largely from renewable natural resources, to produce biodegradable material with similar functionality to that of plastics. This study focuses on understanding the level of awareness about plastic ban and the potential for the use of biodegradable packaging material so as to contain the planet from further deterioration and to restore its heritage to the best of our capabilities.

Index Terms—Plastic, plastic ban, biodegradable packaging material, alternatives for plastics

I. 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 plastics are still used in packaging applications by both organized and unorganized sectors even though it was banned by the Indian Government. These are virtually all non-biodegradable, and some are difficult to recycle or reuse due to being complex composites having varying levels of contamination. Recently, significant progress has been made in the development of biodegradable plastics, largely from renewable natural resources, to produce biodegradable materials with similar functionality to that of plastics. This paper highlights the creation of awareness on plastic ban and the potential impacts of biodegradable packaging materials and their waste management, particularly through composting. It presents the key issues that inform judgments of the benefits these materials have in relation to conventional, petrochemical based counterparts.

This research study discusses the potential impact of biodegradable plastics, with particular reference to packaging,

and waste management via landfill, incineration, recycling or reuse and composting. It provides an overview of the key life cycle issues that identifies benefits that such material have when compared to conventional, petrochemical-based counterparts and create awareness regarding it among respondents.

II. PLASTIC – AN OVERVIEW

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. Every product has a shelf life, but sadly that is not the case with plastics. The fact is that our planet cannot digest plastic nor will it completely degrade in the natural way due to the presence of complex polymers. As a result, till now whatever bit of plastic has ever been manufactured or used by us can be found in some form or the other on the planet. Currently, India generates around 56 lakhs tonnes of plastic waste annually, where Delhi alone accounts for 9,600 metric tonnes per day.

At present, there is only one law in India which states – No manufacturer or vendor can use a plastic bag which is below 50 microns, as thinner bags pose a major threat to the environment due to its non-disposability. The usage of plastic bags is still high as the ban is not implemented on all plastic bags. Many big brands and vendors have started charging the customers for the polybags in order to commercially discourage them, but it is so far not been effective as there is no significant control over it. This induces researchers to analyse the awareness level ban of plastic among the public and to create awareness on biodegradable alternatives for plastics. A simple piece of policy can achieve big results. The need of the hour in India is strict laws and its enforcement for complete prohibition of plastics.

In recent years, recycling of packaging material has increased but the recycling rate for most plastic packaging remains low. A large number of different types of polymers contain different processing additives such as fillers, colorants and plasticizers that are used for packaging applications. This composition complexity together with contamination during use, often render uneconomic recycling compared with disposal in landfill. Although the proportion of waste being landfilled has fallen in recent years, around 60 percent of municipal waste in England still ends up in landfill. This presents environmental concerns, resulting in strengthening of regulations on waste.

Biodegradable plastics with functionalities and process abilities, comparable to traditional petrochemical-based plastic have been developed for packaging applications.

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Typically, these are made from renewable raw material such as starch or cellulose. Interest in biodegradable plastic packaging arises primarily from their use of renewable raw material (crops instead of crude oil) and end-of-life waste management by composting or anaerobic digestion to reduce landfilling. The disposal of packaging materials is particularly significant in view of recent focus on waste generation and management as an important environmental aspect. In addition to performance and price, biodegradable plastics must offer advantages for waste management systems in order to realize an overall benefit.

III. BIODEGRADABLE ALTERNATIVES FOR PLASTICS

Biodegradable polymers (BDPs) or biodegradable plastics refer to polymeric material that are capable of undergoing decomposition into carbon dioxide, methane, water, inorganic compounds, or biomass in which the predominant mechanism is the enzymatic action of microorganisms, that can be measured by standardized tests, in a specified period of time, reflecting available disposal condition. A subset of BDPs may also be compostable with specific reference to their biodegradation in a compost system, and these must demonstrate that they are capable of undergoing biological decomposition in a compost site as part of an available program, such that plastic is not visually distinguishable and breaks down to carbon dioxide, water, inorganic compounds and biomass, at a rate consistent with known compostable material. Initial steps may involve abiotic and biotic processes to degrade the polymer, under suitable conditions, to a low-molecular weight species. However, the resultant breakdown fragments must be completely used by microorganisms; otherwise there is potential for environmental impacts and health consequences. Products of a firm produced in an industrial composting process must meet quality criteria such as heavy metal (regulated) content, eco-toxicity and lack of obvious distinguishable polymer residues.

Depending on their origins, BDPs may be classified as being either bio-based or petrochemical-based. The former are mostly biodegradable by nature and produced from natural origins (plants, animals or micro-organisms) such as polysaccharides, proteins (e.g. gelatine, casein, wheat gluten, silk and wool) and lipids (e.g. plant oils and animal fats). Natural rubber as well as certain polyesters either produced by micro-organism (plants) or those synthesized from bio-derived monomers fall into this category. Petrochemical-based BDPs such as aliphatic polyesters (e.g. polyglycolic acid, polybutylene succinate and polycaprolactone, aromatic copolyesters and poly are produced by synthesis from monomers derived from petrochemical refining, which possess certain degrees of inherent biodegradability character. This classification differentiates between renewable (bio-based) and non-renewable (petrochemical-based) resources, but it should be noted that many commercial BDPs formulation combines material from both classes to reduce cost, and or enhance performance.

Biodegradable plastics, therefore, often comprise polymer

blends that contain partly biogenic (renewable) carbon derived from biomass and partly petrochemical carbon. The following section includes the various biodegradable variants that shall be used in place of plastics, especially in packaging activities.

Cloth- Natural cloth can replace plastic bags. Sustainable clothing made from organic cotton, wool, hemp, or bamboo will not shed plastic fibers when washed. Felted or recycled wool is a versatile, safe, and compostable material for toys, household containers and more.

Wood- As a renewable resource, wood can replace plastic in household items like cleaning brushes, kitchen containers, cutting boards and similar other products.

Bamboo- Bamboo is another fast-growing renewable resource of material that can replace plastic in items like furnishing, baskets, roofing, drinking straws and etc... It is lightweight, durable, and compostable in nature.

Pottery and Ceramics- Earthen pots and other fired ceramics offer a variety of stable, waterproof alternative those are good for food storage and tableware. This is often look for its non-toxic glazes.

Paper- In days gone by, many things were packed in plain paper. Largely, newspapers were used for the purpose of packing, followed by specially made brown covers, which are also paper based. Even though it is better that plastics by degradable feature, paper cannot be recycled infinitely, because every time it's reused, the fibres get shorter, limiting its use. Luckily all paper except the glossy kind is safe to put in our home compost.

Cardboard- Cardboard is fully compostable at home as long as it is not coated with polymers, called laminates. Many firms are now packaging their products in plain cardboard to cut down on waste. Cardboard boxes shall be used to replace storage containers made out of plastics.

Natural Alternatives for Packaging- Many firms are working on fully compostable packaging material. Some of such material already in the market includes mushroom root, seaweeds, pressed hay, banana leaves, leaves of similar other plants and trees.

Objectives- For the purpose of this study the following objectives were formulated:

- To create awareness about the biodegradable packaging items among people
- To study the impact of the ban of plastic packaging items
- To inculcate the potential impacts and benefits of Biodegradable packaging items
- To educate people with regard to waste management, particularly via composting at home
- To suggest ways and means to reduce the use of plastic in the livelihood of people

IV. RESEARCH DESIGN

This study included both empirical and experimental analysis. The nature, scope and application of plastic were studied from reviews of past literature and substantial primary information was gathered from people to strengthen the study. Further, awareness programs were organized and initiatives were taken to stimulate people to use biodegradable packaging alternatives instead of plastics.

Area of the study- The study area included select villages namely,

1. Chinniyampalayam,
2. Neelambur,
3. Kasthurinayakanpalayam (near Vadavalli),
4. Pallapalayam and
5. Pogalur (near Annur).

Period of study- The study was conducted between September and November 2019. The research study was initiated by the PSGR Krishnammal College for Women in Coimbatore, involving the faculty members and students as its research team.

Research Methodology- This study was structured in to three phases. The first phase involved accessing the impact of the ban on plastics and creating awareness about the use of biodegradable packaging items. The second phase included distribution of biodegradable packaging products as samples to households and resellers. The third phase involved periodical evaluation of the impact with regard to this research initiative. Administrative personnel from local bodies and representatives of NGOs were also involved in this study.

Phase I- Meetings and discussions were organized with the local administration personnel and NGOs to conduct this study. Subsequently, social gatherings were organized to meet the residents of the villages and to evaluate their awareness of the ban on plastic products. During such interactions it was observed that, even though most of them were aware of the ban of plastics, they were not greatly influenced to avoid its usage. Presentations about the ill effects of plastics and the advantages of biodegradable packaging items were shared among residents of the area so as to cultivate the practice of using biodegradable packaging alternatives in future. Apart from households, resellers in the locality were also motivated to avoid packaging in plastic material and to use biodegradable material for packaging.

The Research team also educated households and resellers about waste management (Composting). Demonstrations were showcased for composting and illustrious videos were screened.

Phase II- In this phase, samples of biodegradable products such as cloth bags, wooden storage containers, degradable paper bags and covers were given to households as well to resellers in the study area. This effort was to provide an experience for the users so as to build a liking, confidence and feel of comfort while using such packaging, storing and carrying products. The resellers were also provided with the contacts of producers of such biodegradable packaging products so as to purchase in future.

Phase III- The personnel from local administration offices visited the households and resellers to study the impact of the initiative taken and to know its impact. The research team of PSGR Krishnammal College for Women organized a field visit to all the villages where the research was conducted to observe behavioral changes among the residents with regard to biodegradable packaging products and to evaluate the

impact of the effort taken in phase I and II.

V. CASE FACTS

During the course of this study, the following facts were observed:

- People are aware of the ban on plastics by the government but still reinforcement is required
- People are aware about the ill effects of plastic products to some extent
- People were less aware of 'biodegradable' as a concept or an attribute of packaging products
- Consumer care products and household products packaged in plastic are a major threat to the environment

VI. RESULTS AND DISCUSSION

The initiative take in this research effort have observed to have contributed for avoiding plastic packaging products to the best possible degree and to shift towards the use of biodegradable alternatives for packaging, storing and carrying of purchases. Some of the key observations are as follows:

- Peoples are aware of the harmfulness of plastics. They also realized the emergence of avoiding plastic products and the need to use biodegradable alternative products.
- Households and resellers have started using biodegradable cloth bags and paper bags for packaging and facilitating its carrying. A remarkable reduction in plastic packaging and carrying products were observed.
- The researcher facilitated the link between resellers and producers of biodegradable products made out of paper, cloth, wood that shall be used for packaging, storing and carrying of products by households and resellers.
- The research has stimulated the inclusion of biodegradable products in the product line of resellers, enabling business development.
- Bio-plastic polymers have great potential as they contribute for material recovery, reduction of landfill and use of renewable resources.
- An effective infrastructure for collection, separation and composting of domestic and industrial waste will help in efficient monitoring of waste management and its disposal by concerned authorities. Further, it will help in devising strategies and policies for further improvement in this context.

The following table brings our major consumer products made out of plastic or packaged in plastic material which are to be looked upon immediately for replacement with the suggested biodegradable alternative material:

Table 1: Major products and packaging material in plastic and suggested biodegradable alternatives for plastic

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Products made out of plastic	Suggested biodegradable alternatives
Single-use plastic shopping bags	Cloth bags, bamboo baskets
Single-use produce bags	Cloth, jute bag
Items packed in plastic	Glass, metal containers
Plastic bulk aisle bags	Reusable cloth bags, jute bags
Disposable cups	Stainless steel, glass cups
Single-use cutlery	Stainless steel, ceramic cutlery
Disposable straws	Straws of glassware, stainless steel, bamboo, silicone
Plastic lunch baggies	Metal lunch box, beeswax wraps
Storage containers, bags	Silicone bags, metal, wood, glass containers
Liquid dish wash soap, powder	Package in paper, cardboard box
Cleaners in plastic bottles	Glass, metal, cardboard box
Plastic brush and scrubber	Use a natural sponge, luffah, coir
Disposable tableware	Metal, ceramic, glassware, bamboo
Plastic cutting boards	Bamboo, wooden
Plastic plates, cups for children	Bamboo bowls, metal cups
Liquid soap in plastic bottles	Soap bar packaged in paper, cardboard box
Lotion in plastic bottles	Lotion bar wrapped in paper, glass bottle
Disposable feminine products	Menstrual cup, reusable cloth sanitary napkins
Plastic toothbrushes	Bamboo toothbrushes
Liquid shampoo in plastic bottles	Shampoo bar or 'no-poo' method
Plastic trash bags	Reuse paper bags, line with newspaper
Laundry detergent in plastic bottles	Soap nuts or powdered laundry detergent
Polyester carpet	Wool, cotton, jute, wooden flooring
Fabric softener or dryer sheets	Dryer balls
Plastic Curtains	Cotton Curtains,
Decorative items	Decorative items in wood, cloths, paper, cardboard
Clothing, bedding, towels	Organic cotton, wool, bamboo, hemp
PVC, plastic foam board	Wooden, metal board
Plastic sheets, boards	Digital media, metal boards
Vinyl prints	Cloth or cardboard prints

CONCLUSION

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 plastics are still used in packaging applications by both organized and unorganized sectors even though it was banned by the Indian Government. These are virtually all non-biodegradable, and some are difficult to recycle or reuse due to being complex composites having varying levels of contamination. This Research conducted through the awareness programs leads to stoppage of plastic usage in the selected villages.

At the completion of this research program plastic usage was totally stopped in those selected areas. This research has also created business links between the retailers and biodegradable alternative product manufactures as for

increasing the usage of alternative products instead of plastics the researcher found those links for the retailers.

It is understood from this study that the government has to conduct many awareness programs in various areas for complete banning of plastic and made it mandatory the usage of biodegradable products. If the plastics are eliminated from the life, It is not only cutting our own contribution to the waste stream, It is modeling more sustainable living for those around you. Let India Celebrate the successes and spread the word about how important it is to reevaluate the daily habits and what people expect from the companies. As demand for more sustainable business practices grows, companies will continue to respond and the massive increase in plastics use can reverse course the sooner the better.

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