Bio-Degradable Plastic- A Modern Approach For Safe Environment

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Abstract

India and other countries are prone to use synthetic plastic at faster rate for different purposes which pollute environment. This situation can be altered by producing bio-degradable plastic. Maize and soybean crops are growing in India for oil and starch purpose. Starch is one of the important produce can beconverted in to bio-degradable plastic for safe environment.

Introduction

Environmental pollution due to plasticsis a serious threat not only for environment but also for human health. This hazards use for drinking cups and disposable silverware to parts for automobiles and motorcycles. It is rising in faster rate at polluted rivers, oceans, public places, recreation centers and so on.Now adays, plastics are extremely important and essential to thetransport and inmarketing commoditiesas well as packaging industry throughout the world.

The amount of plastic waste in municipal solid waste (MSW) is increasing due to increase in population, urbanization,developmental activities and changes in life style which leads to widespread on the landscape. These are not disposed completely & resulting in to ground and water pollution. Thus disposal of waste plastic is a menace and become a serious problem due to their non-biodegradability and unaesthetic view.

Report of use of plastic in India approximately 8 Million tonnes are consumed every year. Its broad range of application in films, wrapping materials, shopping and garbage bags, fluid containers, clothing, toys, household and industrial products and building materials. It is a fact that plastics will never degrade and remains on environment for several years. Mostly, plastics are recyclable but recycled products are more hazardous to the environment than the virgin products. The recycling of a virgin plastic material can be done 2-3 times only, because after every recycling, the plastic material is deteriorated due to thermal pressure. Considering, 70% of plastic consumption is converted as waste, approximately 5.6 million tons per annum (TPA) plastic waste is generated in country, which equals to 15342 tons per day (TPD). Since use of plastics is a vital to people's everydaylives.Production of biodegradable plastics is an essential component in recent years to make plastics more compatible with the environment [5].In this respect consumption of plastic in cities is as below:

Table 1.Plastic waste in different cities of India

Cities in India	TMSW	PMSW	Total Plastic Waste (TPD)
Kavaratti	2	12.16	0.24
Dwaraka	18	8.28	1.49
Daman	25	4.554	1.14
Panjim	25	4.47	1.12
Gangtok	26	11.12	2.89
Jamshedpur	28	3.216	0.90
Silvassa	35	6.077	2.13
Port Blair	45	10.76	4.84
Kohima	45	5.013	2.26
Shimla	50	4.273	2.14

Meerut	52	6.444	3.35
Gandhinagar	97	4.361	4.23
Shilong	97	5.436	5.27
Itanagar	102	5.352	5.46
Agartala	102	5.712	5.83
Aizwal	107	7.948	8.50
Imphal	120	5.132	6.16
Ranchi	140	5.915	8.28
Kochin	150	6.288	9.43
Dhanbad	150	5.008	7.51
Guwahati	204	5.036	10.27
Asansol	210	6.017	12.64
Dehradun	220	6.665	14.66
Patna	220	5.696	12.53
Raipur	224	10.607	23.76
Rajkot	230	6.92	15.92
Tiruvanandapuram	250	6.022	15.06
Pondicherry	250	10.62	26.55
Chandigarh	264	3.098	8.18
Jammu	300	7.226	21.68
Jaipur	310	5.085	15.76
Vishakapattnam	334	9.033	30.17
Nashik	350	5.822	20.38
Bhopal	350	6.594	23.08
Allahabad	350	5.377	18.82
Jabalpur	400	5.175	20.70
Bhubaneswar	400	7.862	31.45
Madurai	450	5.059	22.77
Varanasi	450	5.78	26.01
Agra	520	7.863	40.89
Srinagar	550	5.117	28.14
Amritsar	550	4.44	24.42
Vadodara	600	4.704	28.22
Vijayawada	600	7.352	44.11
Nagpur	650	6.984	45.40
Coimbatore	700	9.473	66.31
Cities in India	**TMSW**	**PMSW**	**Total Plastic Waste (TPD)**
Faridabad	700	11.65	81.55
Indore	720	8.805	63.40
Ludhiana	850	5.962	50.68
Surat	1200	12.468	149.62
Lucknow	1200	5.886	70.63
Pune	1300	7.971	103.62
Kanpur	1600	6.666	106.66
Bangalore	1700	8.483	144.21
Ahmedabad	2300	10.5	241.50
Kolkata	3670	11.59	425.35
Hyderabad	4200	4.72	198.24
Chennai	4500	9.54	429.30
Mumbai	6500	6.477	421.01
Delhi	6800	10.13	688.84

Total MSW Generated in 60 cities : 48592 MT/Day
Total Plastic Waste Generated in 60 cities : 3905.64 MT/Day

Scientists are searching different methods or plant materials for bio-degradable plastic or polymers which can be environment friendly. In this connection two methods are reported.

1. Starch Based Plastics

Starch based plastics are mainly harvested from wheat, potatoes, rice and maize crops. Out of thesestarch, maize is the most commonly used and is the least expensive.Being an extremely versatile product, about 20% of starch is used for non-food items [1].Starch when harvested is turned into a white, granular product. According to the Australian Academy of Science, "starch can be processed directly into a bio-plastic. It is soluble in water, articles made from starch will swell and deform when exposed to moisture. These starch-based plastics resemble many conventional plastics and are as a biodegradable as pure cellulose material. The process changes the starch from a lactic acid monomer into a polymer chain called poly lacitide (PLA) or polygloycolic (PGA). Both PLA and PGA are crystalline polymers, but PLA is more hydrophobic than PGA. PLA's are very brittle and stiff and they require plasticizers for most applications. High gloss and clarity are other features of PLA plastics. PLA is distinctive because it is available in renewable resources such as the starches. These renewable resources are on the leading edge of technology in Germany where they are being used for pharmaceuticals. PLA can also be processed like most thermoplastics into fibersor it can be thermoformed as well as injection molded. "PLA's can be used in a wide range of applications such as packaging (wrapping film, film for dry food packaging, board lamination etc.), stationery (pens, cartridges, pencil sharpeners etc.), and personal care items [3].

Starch is used for many non-food items such as making paper,cardboard, textile sizing, and adhesives. Starched based plasticshave already been processed into eating utensils, plates, cups and other products .The starch must betransformed into an altered polymer in order to solve the issue of starch deformation. [7]

Biodegradable starches can be processed using conventional plastic technologies such asinjection molding, blow molding, film blowing, foaming, thermoforming and extrusion.

2. Soy Based Plastics

Soy based plastics use another alternative material used for biodegradableplastics. Soybeans are composed of protein with limited amounts of fat and oil. Proteinlevels in soybeans range from 40-55%. The high amount of protein means that they mustbe properly plasticized when being formed into plastic materials.Dr. Amar K. Mohanty is a professor at Michigan State University whose research is primarily in the diverse types of bio-degradable plastic polymers. It is less than 0.5% of the available soy protein is used for industrial products. Soy proteins are used for making adhesives and coatings for paper and cardboard (Steven, 2004)(3). Soy protein may be a first rate material for engineering plastics when a proper moisture-barrier is applied. To lower the water sensitivity, the soy protein can be blended with a polyphosphate filler. In research laboratories it has been shown that soy protein with and without cellulose extenders, can be processed with modern extrusion and injection molding methods.

The films produced are normally used for food coatings, but more recently, freestanding plastics(used for bottles) have been formed from the plasticized soybeans. Ford has takenadvantage of the soy protein plastics and has been using it to manufacturer parts for automobiles [2]

Purpose and Needs of Biodegradable Materials

According to a report from Pira, the UK packaging consultancy has remarkable findings. Annual expenditure on packaging increased by more than 4% between 1994 and 1996, Plastic's share of the total packaging expenditure remained constant over the same period, at 29%. Since there is an abundantamount of waste in the world. There has been a lot of interest in research devoted to create biodegradable materials.

There are many advantages to creating the biodegradable plastics. Starch-based plastics have been proved to be more environment friendly. Starch-based biodegradable plastics have been shown to degrade 10 to 20 times faster than traditional plastics. When traditional plastics are burned, they create toxic fumes which can be damaging to people's health and the environment. If any biodegradable films are burned, there is little toxic chemicals or fumes released into the atmosphere.

Biodegradable plastics have been proved to improve soil quality. This process is performed as the microorganisms and bacteria in the soil decompose the material and it actually makes the ground more fertile [4].

Eventually there is a limit to how many times a piece of plastic can be recycled, so there will in the end there will be waste produced. The cost of recycling plastics, in terms of energy, can be significantly higher than virgin resin. Toxic gases can be releasing fromburning waste plastics in order to harness the energy for production. Many plastics thatappear to be biodegradable in reality break down into miniscule bits that can affect boththe soil and animals. Unfortunately, as researchers try to improve the environment withthese new plastics, in essence they may be creating risks, as well.

Future prospects of biodegradable plastic:

The future of biodegradable plastics shows great potential. Many countries around the world have already begun to integrate these materials into their markets. The Australian Government has paid $1 million dollars to research and develop starch-based plastics. Japan has created a biodegradable plastic that is made of vegetable oil and has the same strength as traditional plastics. The mayor of Lombardy, Italy recently announced that merchants must make biodegradable bags available to all of their customers. In America, McDonald's is now working on making biodegradable containers to use for their fast food [4].

Other companies such as Bayer, DuPont, and Dow Cargill are also showing interest in biodegradable packaging. According to Dr. Mohanty, "demands for biodegradables are forecast to grow nearly 16% per annum." This increasing interest will allow the technology needed to produce biodegradable plastics became more affordable and the falling production costs will eventually lead to an increase in producers ("Plastics", 1998). America and Japan show the greatest potentials for the biodegradable markets. The estimated amount of biodegradable plastics produced per year is about 30,000-40,000 tons over the next five years [2].

Biodegradable materials are accepted in many countries. Thesematerials are thought to help the environment by reducing waste issues. The two mainreasons for using biodegradable materials are the growingproblem of waste resulting in the shortage of landfill availability and the need for theenvironmentally responsible use of resources. As the government and manyorganizations are working to save the environment, there is a definite advantage tomaking biodegradable plastics more of a reality.

Merits on the use of biodegradable plastics:

Compost derived in part from biodegradable plastics increases the soil organic content as well as water and nutrient retention, while reducing chemical inputs and suppressing plant disease.

Biodegradable shopping and waste bags disposed of to landfill may increase the rate of organic waste degradation in landfills while enhancing methane harvesting potential and decreasing landfill space usage.

The energy required to synthesis and manufacture biodegradable plastics is generally much lower for most biodegradable plastics than for non-biodegradable plastics. The exception is PHA biopolymers which consume similar energy inputs to polyethylene's. New feedstock for PHA should lower the energy required for their production.

Biodegradable plastics also offer important environmental benefits through, in many cases, the use of renewable energy resources and reduced greenhouse gas emissions

Conclusion

Reducing the effect of conventional plastics have widespread use in the packaging industry because biodegradable plastics are cost prohibitive. The key issue to bring the costs down, it is essential to have numerous companies buy a large sum of biodegradable materials. Laws of supply and demand state that increasing demand will drive costs down.

Biodegradable plastics must have the same structural and functional qualities, in addition to reacting the same as conventional plastics when used by the consumer. The biodegradable plastics also must be inclined to microbial and environmental degradation upon disposal, without any adverse environmental impact .

Considering importance of Maize and Soya for production of biodegradable plastic. It is essential to know the present consumption in developing countries that maize is consumed directly as food. In India, over 85 percent of the maize production is used as food, while exports are negligible. Most commonly used forms are as (1) Chapattis (2) porridges of various forms (iii) boiled or roasted green ears (iv) breakfast foods like corn flakes and (v) Pop corn. For the (iii) and (v) category sweet and Pop corn varieties are especially grown in USA and Europe. Maize produced in India is utilized for human consumption (33%), starch production (9%), poultry feed (46.5%), brewery (0.5%) and animal feed (11%).[6]

Soya a rich source of protein has applications in food as well as non food sector. In India, out of total production of Soybean, 5% is used for food and feed, 10% for seed and 5% for oil extraction. In food category, Soya is used in Bakery, Meat, Breakfast cereals, Beverages, Infant formula and dairy segment, while soy candle and soy oil cake / meal, biodiesel come under non food category. The products like soya milk, soy paneer (tofu), full fat soy flour, soy nuts and soya fortified biscuits are available in the market. Soya meal is further processed to yield a host of items, viz. soya flour, soya sauce, soya nuggets and, soya-based ready to eat snack foods, etc. Specially soy nuggets are textured soy protein is a potent product. The product is favored by all classes of consumers on all occasions. This indicate that very limited source will be utilize for bio-degradable plastic. [6]

Biodegradable plastics are one of the most innovative materials being developedin thepackaging industry. Companies cannot work fast enough to produce this highlyvaluable technology. Widespread use of biodegradable plastics will be depends onhow strongly society embraces and believes in environmental preservation. The advancement of biodegradable technology hasskyrocketed in recent years and there are growing signs that the public shows a highamount of curiosity in the product. With the variety of biodegradable plastics will be availablein the near future.

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References

[1]W. Liu, A. K. Mohanty, P. Askeland, L. T. Drzal, M. Misra, "Influence of Fiber Surface Treatment On Properties of Indian Grass Fiber Reinforced Soy Protein Based Biocomposites", Polymer, 45, 7589-7596 (2004).

[2]A. K. Mohanty, A. Wibowo, M. Misra, L. T. Drzal, "Effect of Process Engineering on the Performance of Natural Fiber Reinforced Cellulose Acetate Biocomposites" Composites Part A: Applied science and manufacturing, 35, 363 – 370 (2004).

[3]E.S. Stevens <http://www.greenplastics.com> 2001-2004

[4]Emily Kinser. <http://www.eng.iastate.edu/explorer/topics/plastics/bio.htm> 1998

[5]Anonymous .Central Pollution Control Board, Material on Plastic Waste Management , June, 2012

[6]. Sharvari Patil, Maize and Soybean: The Potential Crops for Agricultural Growth Department of Agri Business Management, MITCON Institute of Management, Pune,2010

[7] A. K. Mohantya, B. M. Misraa,. B, G. Hinrichsen, Biofibres, biodegradable polymers and biocomposites. Technical University of Berlin, Institute of Nonmetallic Materials, Polymer Physics, Englische Str. 20, D-10587 Berlin, Germany, 2000