A REVIEW: COMPARISON BETWEEN PRODUCTION OF CONVENTIONAL PLASTICS AND CACTUS PLASTICS: NON-TOXIC TO PLANTS AND ANIMALS

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(Received 28 April, 2021; Accepted 14 June, 2021)

ABSTRACT

Globally, plastics have vast applications, and day-to-day life has been growing in plastic production and use from the 1950’s till now. These plastics were made from different polymers, chemicals, solvents; adhesives, etc. are very dangerous to the humans and animals by pollution caused by them. During production and decaying of plastics (takes nearly hundred to thousand years) releases various chemicals leads to plastic pollution, ozone layer depletion, rise in chemical gases in the environment etc. To overcome these pollution crisis, Dr. Sandra Pascoe Ortiz have started production of plastics with prickly pear cactus plant. This material is completely non-toxic, and all the materials used could be ingested by animals or humans, which do not cause any harm. The cactus plant is widely spread by propagation technique in deserts belonging to the US Department of Agriculture’ (USDA) Hardiness zones (zone 2) and easily cultivated nearby homes. This prospective study states that the cactus plant material is the best material for the production of plastics when compared with other materials with advantages of rapid biodegradability (3 months or within a few weeks in water), nontoxic and also non-risk to humans or animals.

KEY WORDS : Plastics, Polymers, Additives, Cactus plant, USDA, Biodegradable.

INTRODUCTION

One of India’s increasingly growing industries is the plastic industry. In the 1950s, mass manufacturing of plastics began, making them accessible to consumers in a number of contexts (Kumar, 2020). The reasons for popularity for using the plastic bags are light weight, resistance to degradation (by chemicals, sunlight and bacteria), durability and above all low cost (Geyer, 2020). Many chemicals / polymers are extracted from non-renewable crude oil and some of those are used in the manufacturing of plastic materials (Maraveas, 2020). The main sources of plastic entering the atmosphere are land and ocean sources, with the most important contributors being domestic, agricultural and fishing activities (LI, Tse et al., 2016). The polymers in plastic materials are toxic, absorbent and cannot protect the atmosphere from persistent organic contaminants (POPs) (Kumar, 2020) and it is estimated that the time taken for plastics to degrade in the atmosphere was hundreds to thousands of years (Bejgarn, MacLeod et al., 2015). Several toxic chemicals are leaked from plastics during the manufacture, use, disposal (Lithner, Larsson et al., 2011), during degradation process and that have a wide negative effect on biota (Andres, Fielding et al., 1999). The packing of hot edible products in plastic bags allows the migration of harmful chemicals into the food products (Ignatyev, Thielemans et al., 2014). In addition, packaging with plastics may include residues of substances used in the production process such as solvents, accidentally added substances, impurities, oligomers or degradation items et al., 2019).

Globally, plastic waste litters marine environments, most of which are microscopic and
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Beaches are particularly vulnerable to micro-plastic emissions in highly protected natural areas, with contamination levels reaching with greater concentrations (Baztan, Carrasco et al., 2014). Also, during short-term water leaching, hazardous chemicals are leached mostly from plasticized polyvinyl chloride (PVC) and epoxy products (Lithner, Nordensvan et al., 2012). In the Daphnia magna, plastic effluent has earlier been shown to cause deleterious effects (Gewert, Plassmann et al., 2015). Artificial sunlight has regularly leached and weathered plastics from commercially accessible items (Beigarn, MacLeod et al., 2015). No exposure has been paid to the more widely exposed women working in the plastics industry to the adverse effects of chemicals found in different plastic consumer goods (DeMatteo, Keith et al., 2013).

Plastic polymers and their effects during and after production

Polymers are massive organic chemical compounds with atomic mass units of thousands to millions, similar to long chains consisting of a series of intertwined ties that seem infinite (Lithner, Larsson et al., 2011). The polymers which are mostly used in the production of plastics were polypropylene (PP), low density polyethylene (LDPE), linear low-density polyethylene (LLDPE), high density polyethylene (HDPE), polycarbonate (PC), polyethylene terephthalate (PET), polyvinyl chloride (PVC), acrylonitrile butadiene styrene (ABS), polystyrene (PS) (Koshti et al., 2018).

Polystyrene (PS)

Polystyrene is commonly used for packaging many food items, such as beef, dairy products and bakery products, in different types (Thakur, Verma et al., 2018). The presence of styrene monomer in foods can cause problems with cancer, haematology, cytogenetics and neurotoxicity (Pilevar, Bahrami et al., 2019). Styrene inhalation contributes to an elevated level of oxidative stress, which is meant to cause lung damage (Sati, Khaliq et al., 2011).

Bisphenol A (BPA)

Very low doses of BPA exposure are associated with severe problems such as tumours, lack of exercise, neuropsychiatric disorders and endocrine disruption. (Vogel, 2009). It has oestrogenic activity and is extremely poisonous to marine species (Scarascia-Mugnozza, Sica et al., 2011). A climate (aquatic environment, air and soil) may be another cause of BPA exposure, but perhaps the top most priority of environmental contamination seems to be food (Kang, Kondo et al., 2006).

Polyvinyl chloride (PVC)

Among all polymers, polyvinyl chloride has been mainly involved in creating the most serious fire fighting issue today since it releases hydrogen chloride gas while burning (Endo 2002). One hundred and seventy fire fighters who encountered toxicity symptoms were examined from 1970 to 1975 (Dyer and Esch, 1976). Infusion lines can leach plasticizers in significant quantities and are therefore a candidate material for long-term total parenteral nutrition (TPN) hepatotoxic effects (Loff, Kabs et al., 2000). The type widely used for blood transfusions, serum-containing solutions perfused by polyvinyl chloride administration tubing, becomes highly toxic to heart cells isolated in tissue culture (DEHAAN 1971). Polyvinyl chloride biodegradation that has been buried under the soil for more than 32 years (Otake, Kobayashi et al., 1995).

Polyethylene (PE)

Scattered symptomatic lesions, scattered symptomatic lesions without functional disability, generalized functional impairment eruptions, and erosive or ulcerated lesions are caused by polyethylene (Mak, Yeung et al., 2019). These signs are classified as follows by different grades:

- Asymptomatic, moderate erythema, swelling or desquamation are suggested by Grade I (Gao, Liu et al., 2019).
- Painful erythema, swelling, and desquamation of Grade II which do not prohibit regular physical activity (Kumar, Kanna et al., 2017).
- Blistering, ulceration, or swelling in Grade III interferes with daily life, including the ability to wear clothes (Pittura, Avio et al., 2018).
- Grade IV Infection or bedridden condition caused by diffuse or local blistering and ulceration (Heindler, Alajmi et al., 2017).

Analysis of the tissue oxidative stress marker found that the development of lesions was associated with increased oxidative stress (Çobanoğlu, Belvermip et al., 2021). In addition, a comparison of the levels of adverse effects showed that micro plastic beads (MPs) were more harmful to the eyes and reproduction than the kidneys or development (Chisada, Yoshida et al., 2020).
Polyethylene terephthalate (PET)

Polyethylene terephthalate and glass are also commonly used in bottled drinking water products (Parolini, De Felice et al., 2020). PET bottles also increased the release of formaldehyde, acetaldehyde and antimony (Sb), resulting in metal toxicity due to bottle leaching (Bach, Dauchy et al., 2014). It takes about 1000 years for plastics to decompose efficiently (Koshti, Mehta et al., 2018).

The different polymers used for different plastic materials which may use in several purposes like plastic packing, construction, textiles, consumer products, transportation, electrical, industrial machinery (Feldman and Barbalata, 1996).

Effects on human health

The production of plastics has undergone dramatic changes over the past 50 years (Verleye, Roeges et al., 2001). Diverse chemicals are released in the manufacture of plastics (Mangaraj et al., 2019). SO₂ is released as crude oil is refined (4 percent of which is added to plastics), leading to acidification (Mulder, 1998). There is a chance of fire in plastic manufacturing, which can also cause toxic emissions, such as hydrochloric acid vapours produced by PVC burning (Mulder, 1998). There are adverse developmental implications of overdoses of BPA during pregnancy or lactation, including decreased survival, birth weight, early growth of offspring and delayed puberty in male and female rodents (Koch and Calafat, 2009). Chemicals found in plastics can theoretically migrate in contact with the polymer and can also migrate to the surface slowly inside the plastic (Hahladakis, Velis et al., 2018).

Regulations / summit meetings for plastic pollution control

- India hosted the 43rd World Environment Day in 2018, focusing on disposable or single-use plastics with the theme ‘Beat Plastic Pollution’ (Godswill and Godspel, 2019).
- Article 210 requires States to develop a framework for ‘preventing, reducing and controlling dumping pollution of the marine environment’ (Xanthos and Walker, 2017).
- The Central Pollution Control Board and the numerous state Pollution Control Boards enforce the Environmental Protection Act, 1986 (Kumar, 2020).
- Part XII (Articles 192-237) of the United Nations Sea Law Convention (UNCLOS) is dedicated to the safeguards and preservation of the biosphere (Vince and Hardesty 2018).
- Kenya, Tunisia joined African League in 2017, which prohibits the use of plastic packages (Godswill and Godspel, 2019).
- In 2008, the National Oceanic and Atmospheric Association (NOAA) hosted their first workshop on micro plastic pollution, gaining international awareness for the issue.
- The Regulation establishes ‘Specific limits of migration’ These are established on the basis of toxicants for single element by European Food Safety Authority (EFSA) (Hahladakis, Velis et al., 2018).
- US misgivings about contaminants in synthetic materials have always been asserted in the headline of an April 14, 2008, front feature article in the Washington Post (Vogel, 2009).

Alternative to conventional plastics - cactus biodegradable plastic

Cactus plastics, which are biodegradable and non-toxic to humans, animals, and are produced in order to overcome the chemical pollution crisis during plastic production, usage, and degradation. An investigator Sandra Pascoe, has embarked on a

<table>
<thead>
<tr>
<th>Plastic</th>
<th>Effects on human health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyvinyl chloride</td>
<td>Cancer, birth defects, failure of vision, ulcers</td>
</tr>
<tr>
<td>Polycarbonate</td>
<td>Cancer, obesity, hyperactivity, diabetes</td>
</tr>
<tr>
<td>Polystyrenes</td>
<td>Eye, nose and throat irritation, dizziness</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>The carcinogen of humans</td>
</tr>
<tr>
<td>Formaldehyde urea</td>
<td>Birth defects, carcinogens, and genetic changes</td>
</tr>
<tr>
<td>Foam polyurethane</td>
<td>Coughing, bronchitis, skin and eye problems</td>
</tr>
<tr>
<td>Acrylic</td>
<td>Vomiting, diarrhoea, nausea, tiredness, and headache</td>
</tr>
<tr>
<td>Tetrafluoro ethylene</td>
<td>Difficulties with breathing</td>
</tr>
<tr>
<td>Phthalates</td>
<td>Endocrine disruption, asthma, hormonal changes</td>
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</tbody>
</table>
mission to create bioplastics through attempting to make Ficus juice. A researcher has developed a packaging material that is made from the plant and provides a promising solution to one of the greatest plastic effluences in the world (Rodriguez-Felix, 2000). It is non-toxic product to both humans and animals even ingestion does not cause any harm. The differences between conventional plastics and cactus biodegradable plastic were showed in Table 2.

DISTRIBUTION

Prickly pear, belongs to a group Cactaceae and contains approximately 130 taxa and nearly 1500 primates (Bach, Dauchy et al., 2014). A tree native to Mexico is the Opuntia Ficus-indica. In arid semi-arid regions, it has the particularity to grow (Silva, Melo et al., 2017) and it has been distributed through various places, growing conditions and is a drought-tolerant crop (Mayer and Cushman, 2019). By planting the cactus pads in black soil nearby homes, it can be easily cultivated anywhere. In farmlands and in the gardens of residential villages, crops are grown (Pimienta-Barrios, 1994).

MATERIALS AND METHODS

Collection

Nopal cladodes were collected from the INRA Set tat Morocco regional centre experimental station (Allai, Karym et al., 2017). The nopal’s fleshy stalks are long thin harpoons, which are likely to be 7 to 10 mm tall (Agarwala, Agarwala et al., 2008). Experts sliced cartel prickly pear buries on the secondary cladode, more than four years without previous cuts (Silva, Melo et al., 2017). Using cutters, cactus pads or leaves are inserted. The main precaution taken during the collection of pads to avoid thorns is wearing hand gloves.

Extraction method

Wash the pads beneath running water: Lightly scrub the pads with a potato brush under lukewarm water (Barbera, Inglese et al., 1995). Scrubbing the pads removes any sand or dirt from the exterior of the pad, but scrubbing too hard may pierce the pad and cause some of the juice to leak out prematurely (Blanco-Macías, Valdez-Cepeda et al., 2000). Place the pad on a flat counter: Cut away any bruised parts of the pad using a small, sharp knife (Gebremariam, Melaku et al., 2006). Transfer the pads to a large bowl: The bowl should be large enough to fit the pads, and it must also have a large enough mouth for you to work with the pads inside the bowl (Corrales-García, 2007). Crush the pads: Use the flat top of a hammer-style meat tenderizer or other flat kitchen utensil (Dev, Singh et al., 2018). Press the tenderizer against the pads, crushing the juice out. Continue pressing until the pads are thoroughly broken and removed of most of their juice. Strain the juice out: The pad pieces should be relatively large, so the juice should not be too pulpy (Salem, Nefzaoui et al., 2002). Simply pour the juice through a wire mesh strainer and into a separate glass or bowl, allowing the solid portions to remain trapped on the other side of the strainer (Nolen, Allen et al., 2017).

Production

Mixed with non-toxic additives, cactus juice is stretched to produce sheets that are coloured with pigments and folded to form various packaging types (Goldman, Vinokur et al., 2004). The formula is then dried to produce thin sheets of plastic on a hot plate (Nharingo, Zivurawa et al., 2015). Non-toxic additives include glycerine, natural proteins, and in some cases natural dyes are used for consistency of the product (Atti, Mahouachi et al., 2006). In the fight to preserve the environment, Pascoe says her new material would be no more than a “drop in the ocean”.

Table 2. Conventional plastics VS cactus plastic

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Conventional plastics</th>
<th>Cactus plastic</th>
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<tbody>
<tr>
<td>Decaying time</td>
<td>100-1000 years or above</td>
<td>Few weeks to few months</td>
</tr>
<tr>
<td>Ingestion by aquatic organisms</td>
<td>Harmful</td>
<td>Not harmful</td>
</tr>
<tr>
<td>Usage of chemicals</td>
<td>More</td>
<td>Very less</td>
</tr>
<tr>
<td>Toxicity</td>
<td>Superfluous toxic to humans and animals</td>
<td>Non-toxic to humans and animals</td>
</tr>
<tr>
<td>Production</td>
<td>Minor scale to large scale</td>
<td>Minor scale and large scale are in processing</td>
</tr>
<tr>
<td>Additives used</td>
<td>Less toxic</td>
<td>Non-toxic</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSION

In traditional folk medicine, prickly pear has been used due to its role in the diagnosis of illness including inflammatory conditions, biliary dysfunctions (Bach, Dauchy et al., 2014). In many countries around the world, through antioxidant measures and also used in the treatment of High blood pressure, pulmonary tissue, scorches, eczema and stomach problems (Das, Sarmah et al., 2015).

Advantages of cactus plastic compared to other plastics

Production of plastics is very easier when compared to other conventional plastics (Andrady and Neal, 2009). Decaying the plastic in the earth or in marine sources within few weeks, and a detail decaying time of various plastic materials is fast (Grigore, 2017). Processing and preparation of cactus juice user simpler methods like centrifugation and filtration (Guillet, Huber et al., 1992). Additives added to cactus juice is non-toxic and it is not harmful to humans and animals (Pritchard 2012).

CONCLUSION

Globally, Plastic production and usage from past to present has increased gradually. Manufacturing of plastics with polymers, additives, adhesives is very toxic to humans and animals. Degradation of those manufactured materials takes place from 100 to 1000 years. Replacement of those materials to toxic to non-toxic was succeeded by Dr. Sandra Pascoe, a Mexican researcher using cactus plant juice. If any one of its material makes its own way into the ocean, it won’t be a problem if eaten and even if not eaten, it will soon enough dissolve and disappear. The investigator study says that the material begins to break down in soil for a month and when left in water, it breaks down in a matter of days. I conclude that the polymer made with cactus plant is very beneficial to the world which decreases the pollution in the biosphere, reduces the hazardous chemicals, decreases allergic diseases, respiratory disorders, psychotropic abnormalities, convulsions eczema, etc..7

Outlook

This research work should be elongated from small scale to large scale. The usage of plastic difference should be well known to the public which is hazardous or not. By this way, we can prevent pollution and environment from toxic chemicals. Depletion of ozone layer can be prevented by less pollutants. These plastic materials should be distributed widely from one country to all other countries.

ACKNOWLEDGEMENT

I would like to express my special thanks of gratitude to my professors for their able guidance and support in completing my review paper. Secondly, I would also like to thank my friends who helped me a lot in finishing the review article within the time.

Abbreviations

USDA: The United States Department of Agriculture
POPs: Persistent Organic contaminants
PVC: Poly Vinyl Chloride
PS: Poly Styrene
BPA: Bis Phenol A
TPN: Total Parenteral Nutrition
PE: Poly Ethylene
MPs: Micro Plastic beads
PETP: Poly Ethylene Terephthalate
NOAA: The National Oceanic and Atmospheric Association
EFSA: European Food Safety Association
INRA: National Institute of Agricultural Research

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