

SUSTAINABLE BIO-PLASTIC FROM AGRICULTURAL WASTES

Submitted in partial fulfilment of the requirements for the award of

Bachelor of Science Degree in Chemistry

By

PRAVEENA B

(Reg.no:39030020)

RAGUL P

(Reg.no:39030022)



**DEPARTMENT OF CHEMISTRY
SCHOOL OF SCIENCE AND HUMANITIES**

**SATHYABAMA INSTITUTE OF SCIENCE AND TECHNOLOGY
JEPPIAAR NAGAR, RAJIV GANDHI SALAI,
CHENNAI – 600119.TAMILNADU.**

MAY 2022

SATHYABAMA

INSTITUTE OF SCIENCE AND TECHNOLOGY

(DEEMED TO BE UNIVERSITY)

Accredited with “A” grade by NAAC | 12B Status by UGC | Approved by AICTE

Jeppiaar Nagar, Rajiv Gandhi Salai, Chennai – 600 119

www.sathyabama.ac.in

DEPARTMENT OF CHEMISTRY, SCHOOL OF SCIENCE AND HUMANITIES

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **PRAVEENA B (39030020), RAHUL.P (39030022)** who carried out the project entitled **“SUSTAINABLE BIO-PLASTIC FROM AGRICULTURAL WASTES”** under my supervision from December 2021 to April 2022.

Guide

Dr. .V. Kavitha Ph.D.,
Associate Professor
Department of Chemistry

Dr. J. KARTHIKEYAN Ph.D.,
Head of the Department
Department of Chemistry

INTERNAL EXAMINER

EXTERNAL EXAMINER

DECLARATION

We **PRAVEENA.B AND RAGUL .P**, hereby declare that the Project Report entitled **“SUSTAINABLE BIO-PLASTIC FROM AGRICULTURAL WASTES”** done by us under the guidance of **Dr. V. Kavitha** **MSc., M. Phil., Ph.D.**, Associate Professor Department of Chemistry, Sathyabama Institute of Science and Technology is submitted in partial fulfilment of the requirements for the award of Bachelor of Science degree in Chemistry.

DATE:

PLACE:

PRAVEENA B

RAGUL P

ACKNOWLEDGEMENT

We are pleased to acknowledge my sincere thanks to Board of Management of SATHYABAMA for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

We convey my thanks to **Dr. J. Karthikeyan**, Head of the Department, and Department of Chemistry for providing me necessary support and details at the right time during the progressive reviews.

We would like to express my sincere and deep sense of gratitude to my Project Guide, **Dr. V. Kavitha**, for her valuable guidance, suggestions and constant encouragement which paved way for the successful completion of my project work.

We wish to express my thanks to all Teaching and Non-teaching staff members of the Department of Chemistry who were helpful in many ways for the completion of the project.

We take this opportunity to thank my family members and friends for their constant encouragement without which this assignment would not be possible.

PRAVEENA B

RAGUL P

ABSTRACT

The topic on bioplastics is of considerable interest with respect to environment pollution caused by non-biodegradable plastics. Great efforts have been made in producing biomaterials with minimum negative impacts towards the environment. Bio plastic accounted 1% of the 335 million tons of plastics production in a year. The market and demand are continuously growing as the development of new bioplastic. This bio plastic production can be achieved using agricultural wastes as raw material including banana/Fruit peels, corn, wheat, straw, rice straw etc. starch and cellulose are the major raw material for the production of bioplastic.

Key words

- Bio Plastic
- Agricultural waste
- Rice straw

TABLE OF CONTENTS

Chapter No No.	Title	Page
	ABSTRACT	i
	LIST OF FIGURES	v
	LIST OF SYMBOLS AND ABBREVIATIONS	vi
1	INTRODUCTION	
1.1	BIOPLASTICS	1
1.2	ADVANTAGES OF BIO PLASTICS	1
1.3	DISADVANTAGES OF BIO PLASTICS	1
2	LITERATURE SURVEY	3
3	AIM AND SCOPE	9
3.1	AIM	9
3.2	SCOPE	9
4	MATERIALS AND METHODS	
4.1	MATERIALS OF RICE STRAW POWDER	10
4.2	PREPARATION OF LIGNIN AND RICE STRAW POWDER	10
4.3	LIGNIN SOLUTION PREPARATION	11
4.4	POLYVINYL ALCOHOL SOLUTION PREPARATION	11
4.5	PREPARATION OF COMPOSITE FILM	12
4.6.	CHARACTERIZATION TECHNIQUES	
4.6.1	FOURIER TRANSFORM INFRARED SPECTROMETER	12
4.6.2	POWDER X-RAY DIFFRACTION (XRD)	12
4.6.3	SCANNING ELECTRON MICROSCOPY	14
4.6.4	DIFFUSE REFLECTANCE SPECTROSCOPY	14
5	RESULTS AND DISCUSSION	
5.1	CHARACTERIZATION AND TECHNIQUES	16
5.1.1	FTIR	17
5.1.2	XRD	18
5.1.3	SEM	19
5.1.4	UVTEST	21

5.1.5 SOILBURIAL TEST	22
6 SUMMARY AND CONCLUSIONS	23
REFERENCES	24

LIST OF FIGURES

Figure No.	Title	Page No.
4.1	Rice straw	11
4.2	Rice straw powder	11
4.3	Preparation of Lignin and Rice straw Powder	12
4.4	FTIR	13
4.5	XRD	14
4.6	SEM	15
4.7	DRS	16
5.1	Lignin	17
5.2	FTIR spectrum of lignin and lignin-PVA composite	18
5.3	XRD plot for lignin and lignin-PVA composite	19
5.4	SEM photographs of PVA and lignin-PVA composite	20
5.5	UV Transmittance plot	21
5.6	UV Absorbance plot	22
5.7	Soil Burial test	23

LIST OF ABBREVIATIONS

FTIR	- Fourier Transform Infrared Spectroscopy
SEM	- Scanning Electron Microscope
XRD	- X-Ray Diffraction
UV	- Ultra Visible

CHAPTER 1

INTRODUCTION

The world's awareness on the depletion of natural resources and pollution issues increasing over the past few decades a consequence. Research effects have been developed at different levels to find alternative solutions. Bio plastics contribution by Lowering the dependence on fossil fuels and reducing the carbon dioxide emissions

Interest in utilization of renewable resources is increasing because of depleting resources. Environmental responsiveness, economic considerations, biobased biodegradable polymers and composites derived from renewable biomass feedstock can be a powerful demonstrative case of relevant dimension for sustainable development. Natural fibres with renewable resources-based polymers benefit the environment as they can be biodegradable, compostable and recyclable, and reduce greenhouse gas emissions.

1.1 Bio-plastic

An estimated 99% of all plastic is made from fossil fuels such as oil and gas. The remaining 1% is made from natural raw materials such as corn, cane sugar, or potatoes, these bio-plastic are used for bags, food packaging disposable cups. Etc. Even though they may eventually biodegrade if disposed of properly. Bio-plastic behaves like ordinary plastic in the environment and therefore, cannot be a long-term solution for the plastic cup.

1.2 Advantages of bio-plastics

- Biodegradable Plastics are Easy to Recycle
- They Consume Less Energy During Their Manufacture
- Reduction of the Amount of Waste Produced
- Lower Petroleum Consumption
- Composability
- Reduction of Carbon dioxide Levels
- Reduction of Emission of Greenhouse Gas Levels

- Biodegradable Plastics Products Do Not Release Harmful Products Upon Decomposing
- Biodegradable Plastics Products are Broken Down by Bacteria That Occur Naturally.

1.3 Disadvantages of plastics

- Natural decomposition of plastic can last from 400-1000 years and few types of plastics are non-degradable as well.
- Plastic materials clog waterways, oceans, seas, lakes etc. 1 in 3 species of marine mammals have been found entangled in marine litter.
- Many animals eat plastic materials and die. Over 90% of all seabirds have plastic pieces in their stomachs.
- Its cost of recycling is also very high
- Plastic is widely used in packaging. Eating food out of plastic containers may cause cancer.

CHAPTER-2

REVIEW OF LITERATURE

1)Biodegradable plastic applications towards sustainability

Authors; Taofeeq,D. Moshood,GusmanNawanirFatimah,Mahmud andFazeeda Mohamad

The purpose of this study is to investigate the contribution of biodegradable plastics to Sustainability in a new and sustainable plastics economy, in which plastics perform their useful function without causing negative externalities. Biodegradable plastics are those that degrade naturally over time.

2)Sustainable Green Composites: Value Addition to Agricultural Residues and Perennial Grasses

Authors; Nagarajan, Vidhya; Mohanty, Amar K.; Misra, Manjusri (2013). ACS Sustainable Chemistry & Engineering

The researcher findsPHBV/PBAT/MS showed increased tensile strength, modulus, HDT, and MFI, while exhibiting a relatively low percentage of water absorption and he finds perfect results in 45 degreesCelsius

3)Production of biodegradable plastic from agricultural wastes

Authors; N.A. Mostafa, Awatef A. Farag, Hala M. Abo-dief, Aghareed M. Taye

Colors, dusts, and fats were removed from flax fibers and cotton linters by washing with water and bleaching with 120 mL of household bleaching agent (5% NaCl & 5% NaOH), thoroughly washing and, then, was followed by drying. A sample of 35 g of each raw material was used. Acetic anhydride(100 mL), glacial acetic acid (100 mL) and sulfuric acid(10 mL) were mixed and the mixture was cooled to 7 °C. Flax fibers or cotton linters were added slowly to the previous mixture with agitation to bring about the acetylation process; this step produced the primary CA. Hydration of the primary CA (viscous fluid) was achieved by diluting with 30 mL of equal parts of concentrated acetic acid (99.8%) and sulfuric acid (98%) and, then, the primary CA was allowed to age for 15 h. The resulting viscous fluid was centrifuged in order to separate the final product. Plasticizer (polyethylene glycol 600) was added as 25% by volume of the viscous CA with agitation; this formed the final product which was dried in an oven at 60 °C until a constant weight in order to get the product ready for use. Before being

shaped, the product was diluted with acetone to bring it into the form of a viscous fluid which could be poured in a mold or on a smooth surface for shaping.

4) Synergic Effect of Nano lignin and Metal Oxide Nanoparticles in to Poly (L-lactide) Bio nanocomposites: Material Properties, Antioxidant Activity and Antibacterial Performance

Authors; Lizundia, Erlantz, Armentano, Ilaria, Luzi, Francesca, Bertoglio, Federico, Restivo, Elisa; Visai, Livia, Torre, Luigi; Puglia, Debora (2020).

5) Recycling and elimination of wastes obtained from agriculture by using nanotechnology: nan sensors

Authors; Alvarado MA, Guzmán ON, Solís NM, et al. Int J Biosen Bioelectron

6) Article Name: Bioplastics from agricultural waste

Authors: Jia Xin Chan, Joon Fatt Wong, Azman Hassan, Zainoha Zakaria

The research on starch generally focused on the processing of thermoplastic starch, blending of thermoplastic starch with various synthetic polymers, and starch-reinforced polymer composites. Most of these researches used starch that serves as food sources to produce plastic and led to the issue of food scarcity. Some of the examples are cassava starch, corn starch, and potato starch. In this case, it is better to produce bioplastics from starch that originated from agricultural waste

7) Sustainability of Biodegradable Plastics:

Authors: Taofeeq, D. Moshood Gusman, Nawanir, Fatimah Mahmud, Fazeeda Mohamad, Mohd Hana, Fiah Ahmad and Airin Abdul Ghani

8) Sustainability Opportunities and Challenges of Bioplastics:

Authors: Eri Matsuura, Yan Ye, Xiaoxuan H

Each type of plastic has unique properties and goes through different manufacturing processes. Products types also vary and the required additives and sub materials that are needed in the production process. Despite PLA is the most successful and commercialized plastic among BPs, its demand is still increasing in the growing BP market. Rohm and Haas are also interested in developing PLA additives. Therefore, this study particularly focused on PLA plastics production process and assessed its sustainability performance.

9) Bioplastics for a Circular Economy

Authors: Jan-Georg Rosenboom, Robert Langer & Giovanni Traverso.

Source of polysaccharides is seaweed. Which includes brown and red algae. The most abundant polysaccharides in brown algae are alginates, which comprise up to 40% of their dry weight. Alginates can react and gel with divalent or trivalent cations and can be blended with starches to make biodegradable plastic films with low gas permeability and other desirable mechanical properties.

Vegetable and plant oils also provide access to various monomers. Similar to sugars, edible oils raise concerns over food competition and deforestation. While non-edible oils or waste oils are more ethically and ecologically viable.

10) Sustainable Sourcing of Feedstocks for Bioplastics.

Authors: Julia Lovett - Corbion François de Bie

To make the C5 and C6 sugars an efficient and effective feedstock for Corbion, two different technology routes could be followed. Isolate and purify the C6 sugars from the mix of C5 and C6 sugars. Corbion would buy the purified C6 sugars and feed them into the regular production processes. This route requires efforts from Corbion, but the major effort and capital investment will be with the 3rd party that would deliver the purified C6 sugars. Feed the unpurified mix of C5 and C6 into the Corbion fermentation process. This route requires R&D efforts and process optimization from Corbion a new fermentation strain needs to be developed and a new production process, requiring a new production plant, needs to be built. Corbion has invested significantly in both technology routes. Corbion welcomes suppliers throughout the supply chain to collaborate in reducing the time to market for PLA products made from alternative feedstocks.

11) Bio-Based and Biodegradable Plastics

Authors: Martien van den Oever, Karin Molenveld, Maarten van der Zee, Harriëtte Bos

A variety of biodegradable polyesters has been developed in the eighties of the previous century. These biodegradable polyesters are predominantly based on fossil fuels. These materials are mainly used in combination with bio-based polymers like starch and PLA. The most frequently used biodegradable polyesters are PBAT, PCL and PBS(A). Partly bio-based PBS is commercially available. 4.5.1 Flexible films based on biodegradable polyesters A large product group containing biodegradable polyesters are flexible films. Applications range from shopping

bags, food packaging films, waste bags to mulching films. The predominantly fossil-based biodegradable polyesters are often combined with bio-based materials. Examples are: Starch based flexible films containing polyesters like PBAT to improve processability, water resistance and tear strength. The content of biodegradable polyesters is commonly 50% or more. PLA based flexible films containing polyesters like PBAT, PBS and PCL to reduce stiffness and improve tear strength. Again, the content of biodegradable polyester is usually high (> 50%).

12) Environmental Sustainability of Plastic in Agriculture

Authors: Department of Civil Engineering, University of Patras, 26500 Patra, Greece

The production of HDPE plastics is associated with a 52% global warming potential of the entire production process. Additionally, a comparative analysis of biodegradable (PLA) and non-biodegradable polymer (PE) in Table 3 shows that the synthetic process of the latter a minimal threat to the environment. In particular, the energy demand for PLA4 is 24 MJ/kg; this contrasts with 76 MJ/kg for PE. The data shows that the production of synthetic plastics requires threefold higher energy. The GHG emissions kg CO₂ equivalent/kg is higher for PE compared to PLA (4.8 vs. 1.8). The estimates are consistent with the global forecast, which showed that the production of synthetic plastics generated 1.7 Gt of CO₂-equivalent. Since agricultural plastics account for 2% of the global demand, 340 megatons of CO₂-equivalent were generated from agricultural-related applications; this is an issue of environmental concern because carbon emissions are projected to increase fourfold by 2050. The ecological risks could be mitigated by the commercialization and production of bio-based plastics with suitable mechanical, optical, and radiometric properties

13) Study of Bio-plastics As Green & Sustainable Alternative to Plastics

Authors: R. Laxmana Reddy, V. Sanjeevani Reddy, G. Anusha Gupta

PLA (Poly Lactic Acid) is one of the most environment friendly Bio-plastic available today. It is made from 100% bio based resources and has multiple end-of-life options (i.e., 100% recyclable and biodegradable). PLA is a highly efficient plastic. To make a kg of PLA it requires a meager 1.6 kg of sugar. Other types of bio-plastics can require significantly more natural resources to produce the same

amount of end-product. Emission of carbon dioxide is less when compared with other polymers

14) Bioplastics and biodegradable plastics

Author: Chris Woodford.

Publication Date: February 10, 2022

Ironically, plastics are engineered to last. You may have noticed that some plastics do, gradually, start to go cloudy or yellow after long exposure to daylight (more specifically, in the ultraviolet light that sunlight contains). To stop this happening, plastics manufacturers generally introduce extra stabilizing chemicals to give their products longer life. With society's ever-increasing focus on protecting the environment, there's a new emphasis on designing plastics that will disappear much more quickly.

15) Microbial Production of Biodegradable Plastics from Agricultural Waste

Author: Mukesh Chander.

Publication date: June 2019

Materials used in this production can be obtained from local market such as cassava tubers, vegetable oil, filter cloth, plastic wrap, aluminum foil, chemicals such as glycerol and ethanol. Equipment required are vacuum oven, drying tray, magnetic stirrs, centrifugation. Cassava starch has been expanded under the very extrusion conditions. It has a bulk density, Due to this a little modification is required so that the moisture content can be increased. Cassava starch can be expanded in molds, at 200-240°C for 1-3 minutes. As a major source of starch in tropical and subtropical regions, cassava is promising raw material for the production of Biodegradable Plastic in these areas.

CHAPTER-3

AIM AND SCOPE

3.1 Aim

Aim of the project is to get bio-plastic film from agricultural waste of the Rice Straw, bio-plastic is a bio-degradable material that come from renewable sources and can be used to reduce the problem of plastic wasteand polluting the environment, bioplastic can replace plastics in the field oftheir application also andcanbeused asgood packaging, plasticstorage bags storage containers another plasticorcomposite material.

3.2 Scope

Bioplastics remain less than one percent of all plastics manufactured worldwide. Most. bioplastics do not yet save more carbon emissions than are required to manufacture them. It is estimated that replacing 250 million tons of the plastic manufactured each year with bio-based plastics would require 100 million hectares of land, or 7 percent of the arable land on EarthBioplastics are able to biodegrade in different environments hence they are more acceptable than conventional plastics.Biodegradability of bioplastics occurs under various environmental conditions including soil, aquatic environments and compost. Both the structure and composition of biopolymer or bio-composite have an effect on the biodegradation process, hence changing the composition and structure might increase biodegradability. Soil and compost as environment conditions are more efficient in biodegradation due to their high microbial diversity. Composting not only biodegrades bioplastics efficiently but it also significantly reduces the emission of greenhouse gasesSoil environments on the other hand have high diversity of microorganisms making it easier for biodegradation of bioplastics to bioplastics are extremely advantageous because they reduce non-renewable consumption and GHG emissions, they also negatively affect the environment through land and water consumption, using pesticide and fertilizer, eutrophication and acidification; hence one's preference for either bioplastics or conventional plastics depends on what one considers the most important environmental impactbioplastic environmental impacts are categorized into nonrenewable energy use, climate change, eutrophication and acidification.Bioplastic production

significantly reduces greenhouse gas emissions and decreases non-renewable energy consumption.

CHAPTER-4

MATERIALS AND METHOD

4.1 Materials Rice Straw Powder.

Rice straw powder, rice straw we bought from rural areas after sun dried make it as fine powder, choline chloride, Tartaric acid and oxalic acid and poly vinyl alcohol, NaoH from laboratory.



Fig.4.1 Rice straw

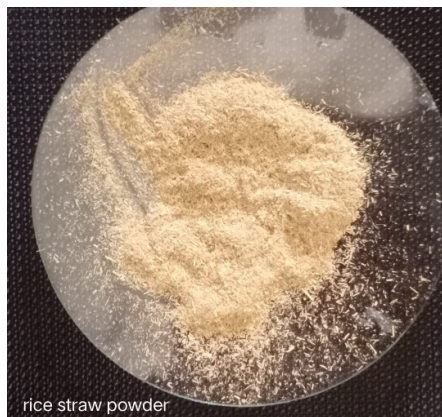


Fig.4.2 Rice straw powder

4. 2 Preparation of Lignin and Rice Straw Powder

First have to know which compounds gives lignin in the temperature of 80-90 degree Celsius, so tried with Trisodium citrate 1g with choline chloride 0.25 g acid in the temperature of 80-90 degree Celsius, no reaction was happened with this particular compound didn't get lignin solution, similarly tried with phthalic acid 0.5g, Benzoic acid 0.5 g, Tartaric acid 0.25 g and cinnamic acid 0.5 g, no reaction was happened with these combination to get lignin solution, then taken 1 g of rice straw powder and choline chloride 0.25g and oxalic acid 0.25 g in the beaker, heat it with the help of magnetic stirrer in the temperature of 90-100 degree Celsius, for 4 hours, the solution turns into a liquid stage, then cool the solvents for 1 hour then add distilled water then check the pH level between 4-5, leave the solution for overnight, after filter the solution to get precipitate

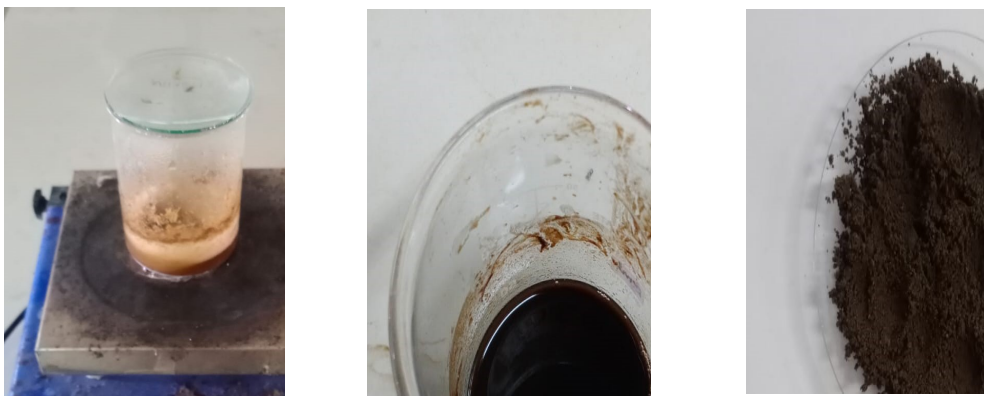


Fig.4.3 Preparation of Lignin and Rice Straw Powder

4.3 Lignin Solution Preparation

To prepare lignin solution we need to take rice straw powder 0.5g, NaOH solution- 5g and distilled water 50 ml, in 0.5 gram of rice straw powder have to add 5gram of NaOH solution and 50 ml of distilled water. Then leave it the solution in normal room temperature for 1 hereafter that we got the lignin solution.

4.4 Polyvinyl alcohol solution preparation

To prepare polyvinyl alcohol solution we need to heat the 100 ml distilled water in beaker with help of magnetic stirrer, after heating the distilled water have to add 3g of polyvinyl alcohol heat the solution till polyvinyl alcohol mix it with distilled water and turns into solution.

4.5 Preparation of composite film

To prepare composite film have to add lignin solution and poly vinyl alcohol in various ratio, with the help of help of pipette and petri dish to get the film, lignin 1 ml and add 9 ml of PVA in the temperature 30 degree Celsius leave the solution for overnight after got the film weight of 0.47 g, after 2 ml of lignin add 8 ml of PVA in the temperature of 30 degree Celsius , leave the solution for overnight then get a 0.54 g weight of film, after 5 ml of lignin then add 5 ml of PVA in the temperature of 30 degree Celsius , leave the solution to overnight then get film weight of 0.61 g, after 0 ml lignin and 10 ml PVA in the temperature of 30 degree Celsius leave the solution for overnight and get the film weight of 0.24 g, after have to add 3 ml of lignin with 7 ml of PVA in the temperature of 30 degree Celsius, leave the solution for overnight and get the film weight of 0.47 g

4.6. CHARACTERIZATION TECHNIQUES

4.6.1 Fourier Transform Infrared Spectrometer

FTIR stands for Fourier transform infrared, it is a versatile tool for surface characterization of nanoparticle. It involves in various phenomena such as the adoption, reflection, and emission of light using the sample and it is used to identification of organic, inorganic, and polymeric materials using infrared light for scanning the samples. FTIR is useful in identifying and characterizing unknown materials, detection contaminants in a material, finding additives, and identifying decomposition and oxidation. FTIR spectrometer includes a source, sample cell, detector, amplifier, A/D convertor, and a computer. when IR radiation is passed through a sample, some radiation is absorbed by the sample and some passes through (is transmitted), radiation from the source reach the detector after it passes through the interferometer. The signal is amplified and converter to a digital signal by the A/D converter and Amplifier, then the signal is carried to the computer. The resultant signal obtained at the detector is a spectrum generally from the range of 16 4000-400 cm^{-1} which represents the fingerprint range of sample. For this purpose, the sample were mixed potassium bromide and made into pellets for analysis.



Fig.4.4 FTIR

4.6.2 Powder X-Ray Diffraction (XRD)

Since most materials have unique diffraction patterns, when an X-ray is incident on the crystal they scattered in accordance with Bragg's law, it diffracts and produces different patterns. Which assumes the diffraction to take place only when the distance travelled by the rays reflected from the successive planes of crystal, by scanning the sample through a range of 2θ angles, plotting the angular positions and intensities of the resultant diffracted peaks produced the pattern. Finally, matching the resultant diffraction peaks to characterize, finally the resultant patterns are also studied for the position of diffraction maxima, peak intensities, and the intensity distribution as a function of the diffraction angle, Here the diffracted pattern is obtained from a powder of the material. Compounds can be determined from its diffracted pattern. Powder diffraction is often easier and more convenient than single crystal diffraction, the purity of a sample can also be determined from its diffracted pattern, Powder X-ray diffraction is a characterization tool that offers a detailed view of the crystallographic structure and chemical composition of the sample. The particle size can be determined by using the Scherrer formula is

$$\text{Scherrer formula} = (D = K\lambda/\beta\cos\theta)$$

15 Where, K = shape factor (0.9)

λ = wavelength of X-rays,

β = corrected full width at half-maximum;

θ = angle of peak

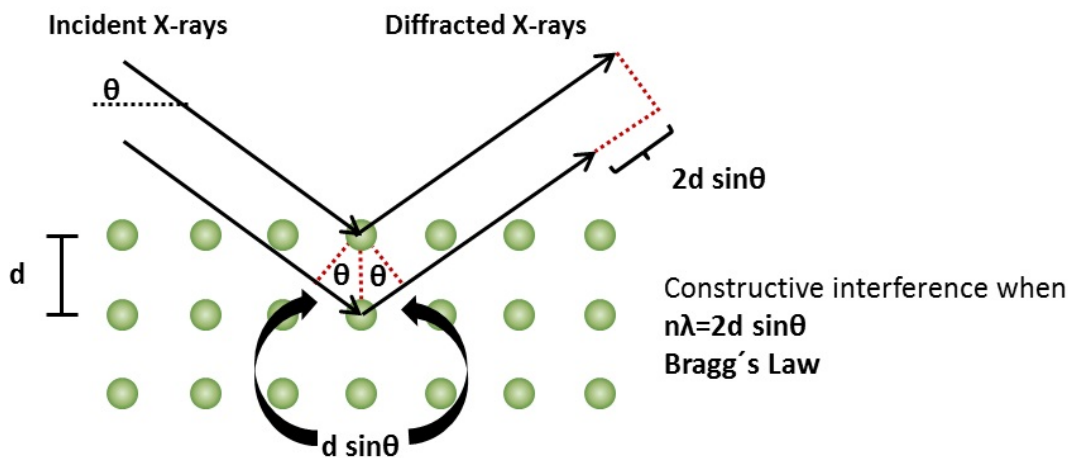


Fig.4.5 XRD

4.6.3 Scanning Electron Microscopy

Scanning electron microscope (SEM) uses a focused beam of high-energy electrons to generate a variety of signals at the surface, the signal comes out from the electron- sample interaction reveal the information about the sample including external morphology, chemical composition, and crystalline structure and orientation of materials making up the sample. it a high-resolution image of the size and surface texture of the particle, SEM equipped with EDX can determine the main atomic composition of pf the particle, particle colors cannot be determined by SEM. SEM/ESEM-EDX. SEM is one of the main testing instruments for in situ analysis of micro areas. It has high magnification, and strong stereoscopic view. Photographs taken by SEM have higher magnification and clearer definitions than those by optical microscopy. SEM can be used to measure only elements with atomic coefficients less than 5. The SEM is also capable of performing analyses of selected point locations on the sample. This approach is especially useful in qualitative determining 17 chemical compositions. In SEM examination system the zones territory from around 1cm to 5 microns in width can be imaged in a filtering mode utilizing SEM methods and having amplification run from spatial goals of 50nm to 100nm. Fig 4.3 ScanningElectron Microscopy

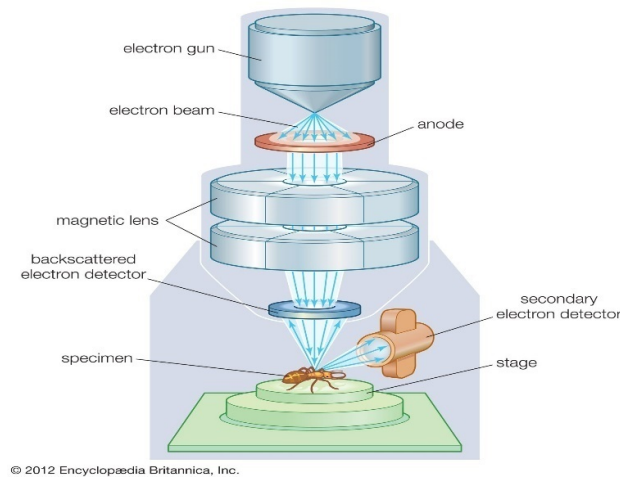


Fig.4.6 SEM

4.6.4 Diffuse reflectance spectroscopy



Fig.4.4 DRS

Diffuse reflectance spectroscopy, or diffuse reflection spectroscopy, is a subset of absorption spectroscopy. It is sometimes called remission spectroscopy. Remission is the reflection or back-scattering of light by a material, while transmission is the passage of light through a material. The word remission implies a direction of scatter, independent of the scattering process. Remission includes both specular and diffusely back-scattered light. The word reflection often implies a particular physical process, such as specular reflection.

CHAPTER-5

RESULT AND DISCUSSION

5.1 CHARACTERIZATION AND TECHNIQUES

Table- 5.1

1	1g of Rice Straw + 13g of Choline chloride + 13g of oxalic acid	Weight of Lignin – 3.70g
2	1g of Rice Straw + 10 g of Choline chloride + 10g of oxalic acid	Weight of Lignin - 1.51g
3	1g of Rice Straw + 10g of Choline chloride	No Reaction
4	1g of Rice Straw + 10g of Oxalic acid	No Reaction



Fig.5.1 Lignin

5.1.1 FTIR

The Lignin, PVA, lignin-PVA composite film samples were scanned in the range of 4000cm^{-1} to 400cm^{-1} to explore the nature of functional groups present in the molecule and the results are presented in Fig. The lignin particles show a characteristic peak at 3289cm^{-1} , 2984cm^{-1} and 1056cm^{-1} due to the presence of hydroxyl groups (-OH) stretching vibrations. A characteristic peak at 1458cm^{-1} is due to the C-H vibrations. The surface of the lignin particles is composed of hydrophilic hydroxyl groups which have a strong ability to interact with hydroxyl groups of PVA. The absorption band for PVA at 3370cm^{-1} represents the hydroxyl (-OH) stretching vibrations. This band shift to lower frequency in the composite film and exhibits a peak at 3355 and 3329cm^{-1} for 2:8 and 5:5 ratio of lignin-PVA composite. The shift to lower frequency (red shift) in the composite film is due to the presence of lignin to PVA matrix. The shift in band indicates the presence of

intermolecular hydrogen bonding between the hydroxyl groups of lignin and PVA matrix. The band at 2924cm^{-1} , 2909cm^{-1} and 2893cm^{-1} in PVA, 1:9 and 2:8 lignin-PVA composite film which represents a characteristic peak for C-H stretching vibration. The band at 1087cm^{-1} for PVA shows a red shift to 1076cm^{-1} and 1061cm^{-1} for 1:9 and 2:8 composite film representing C-O stretching vibration.

5.2 X-RAY DIFFRACTION (XRD)

XRD is one of the characterization methodology which results from the diffraction pattern of the samples and is associated with the crystallinity of the sample. The XRD diffraction pattern of lignin, PVA and lignin-PVA composite film is shown in the Fig. The XRD pattern is obtained by scanning from 10° to 60° with a scan rate of $0.001^\circ/\text{sec}$. A sharp peak at 2θ values of 32.07° ; 34.80° ; 38.75° ; are typical peaks of lignin particles. A peak at 29.21° and 34.36° shows an increase in intensity as the lignin content increases from 1:9 to 5:5 ratio of lignin-PVA composite mixture which indicates the interaction of lignin with PVA matrix. The crystallite size for lignin particles as calculated by Scherrer equation is found to be 144-184 nm.

5.3 SCANNING ELECTRON MICROSCOPY (SEM)

The structural morphology of the PVA and lignin-PVA composite film is presented in the Fig.5.3. The morphology of pure PVA is in the form of uniform dispersion of while the Lignin-PVA composite film assumes the form of bulky rod shape of lignin particles dispersed in PVA matrix in the sample ratio of 2:1. Similar bulky rod like structure was obtained in the other samples of lignin-PVA composite film. The EDAX plot for PVA and lignin-PVA composite film is shown in the Fig. The oxygen content for PVA measured at 0.5Kev is found to be 30% while in the lignin-PVA composite film of (5:5) ratio is found to increased to 50%. Increase in oxygen content is due to the presence of lignin particles in the film containing many polarisable hydroxyl groups.

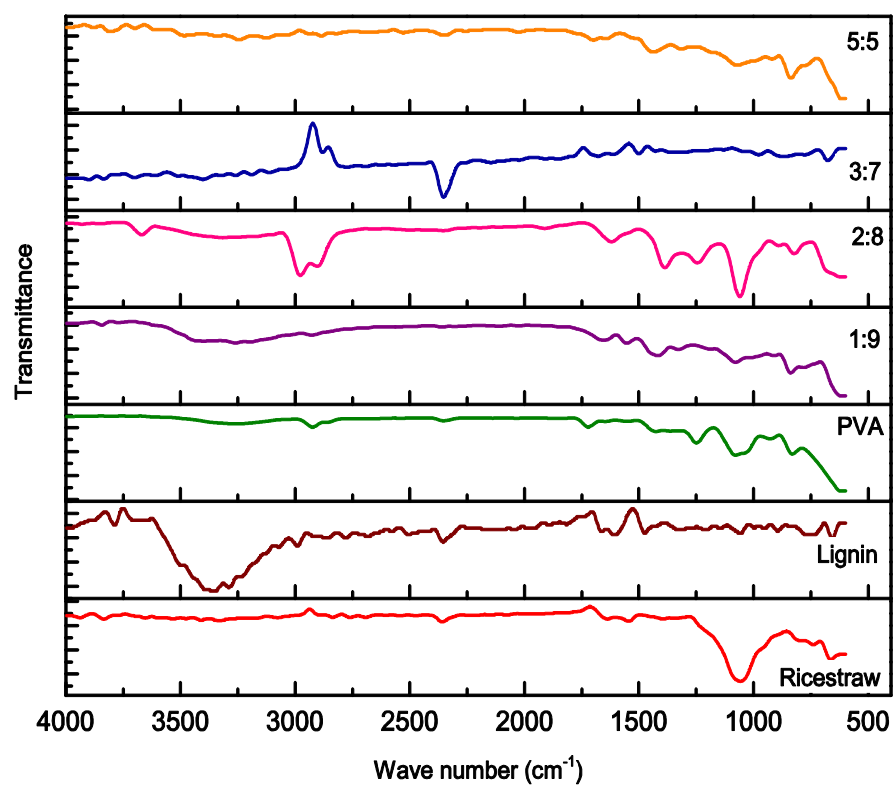


Fig.5.2. FTIR spectrum of lignin and lignin-PVA composite

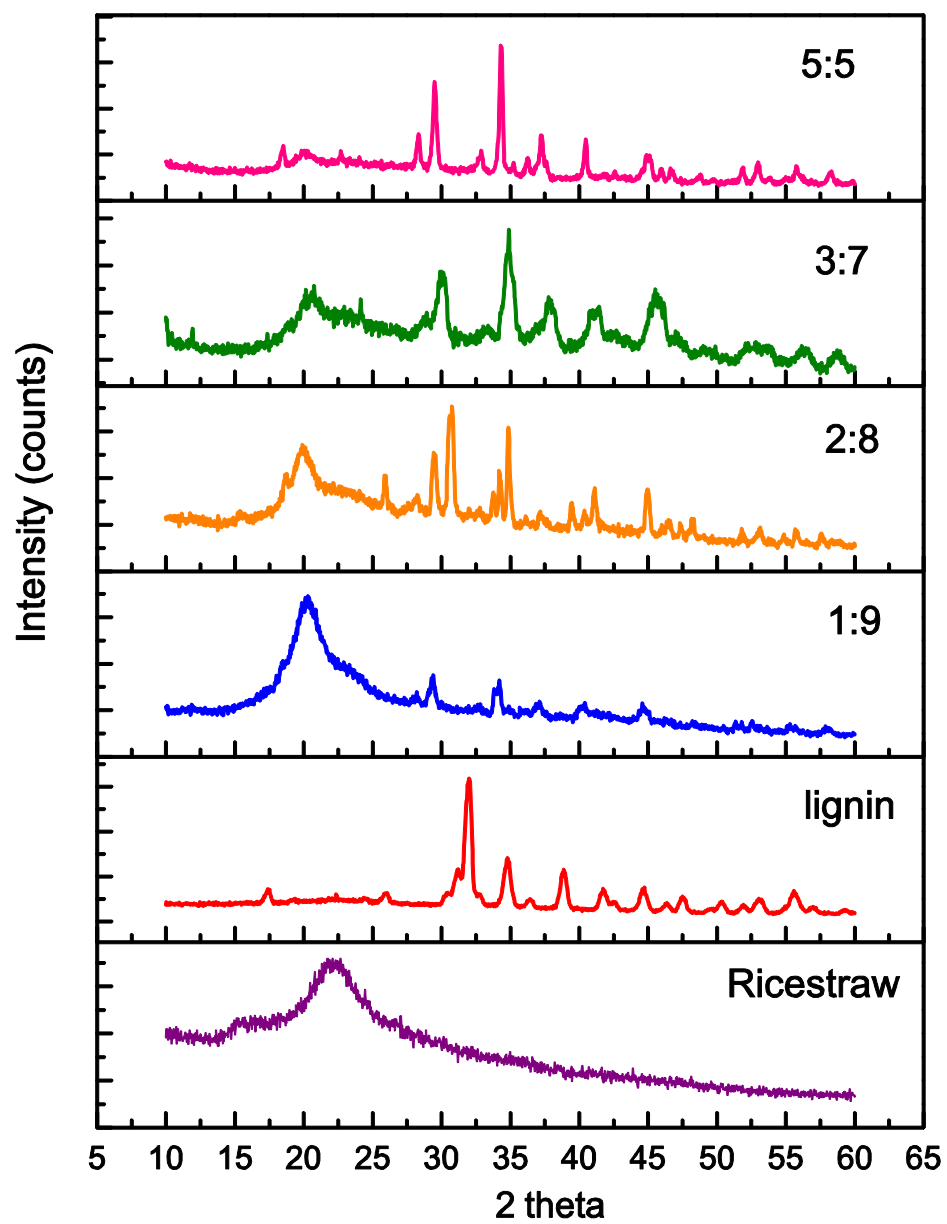


Fig 5.3 XRD plot for lignin and lignin-PVA composite.

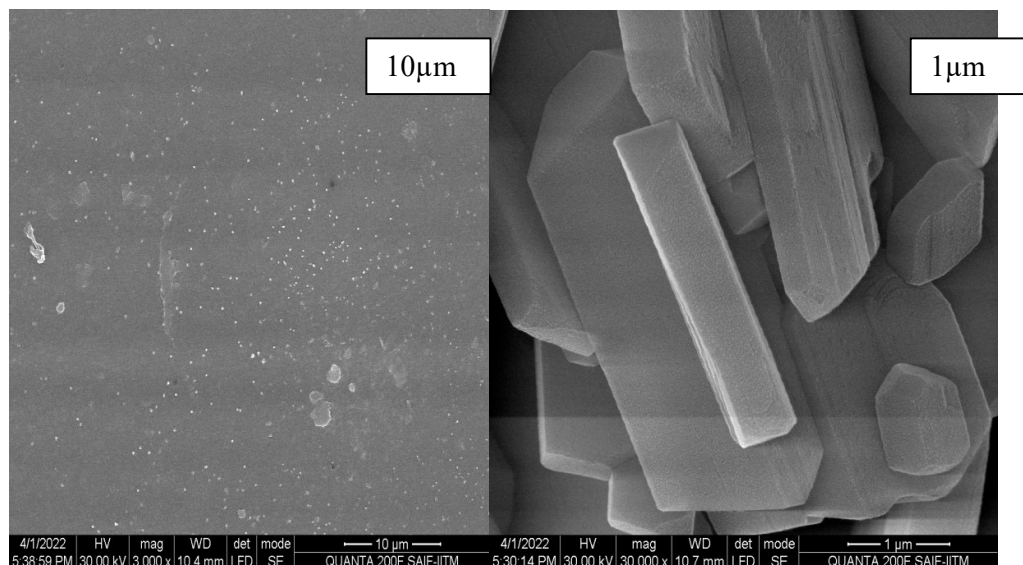


Fig5.4 SEM photographs of PVA and lignin-PVA composite

<i>Element</i>	<i>Wt%</i>	<i>At%</i>
<i>CK</i>	67.25	73.79
<i>OK</i>	30.54	25.16
<i>NaK</i>	01.16	00.67
<i>ClK</i>	01.05	00.39
<i>Matrix</i>	Correction	ZAF

<i>Element</i>	<i>Wt%</i>	<i>At%</i>
<i>CK</i>	20.33	27.84
<i>OK</i>	48.54	49.90
<i>NaK</i>	31.13	22.27
<i>Matrix</i>	Correction	ZAF

5.1.4UV TEST

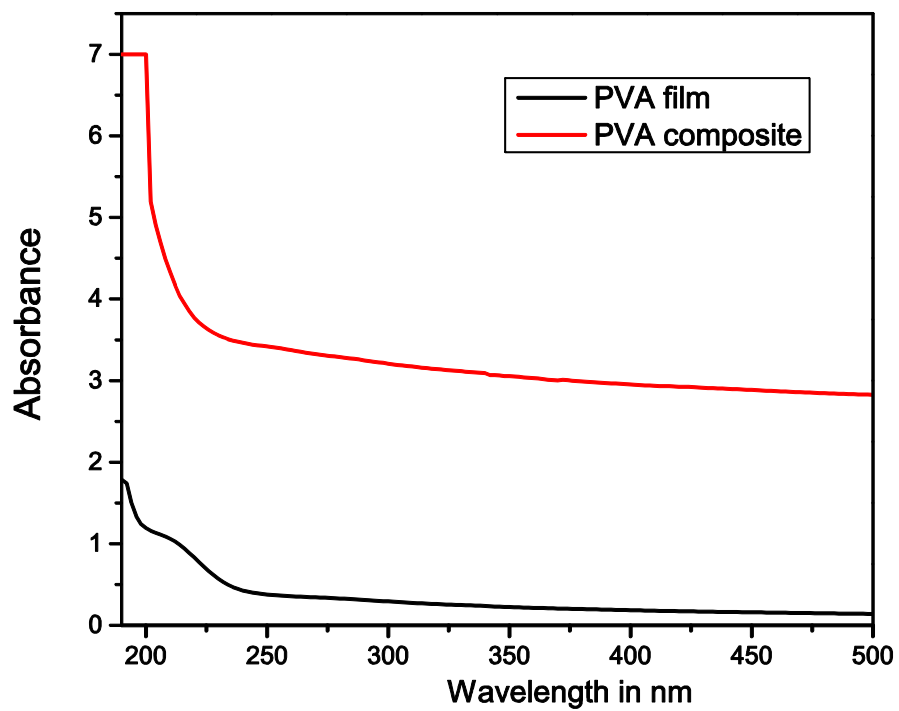


Fig5.5 Absorbance plot for lignin and composite film

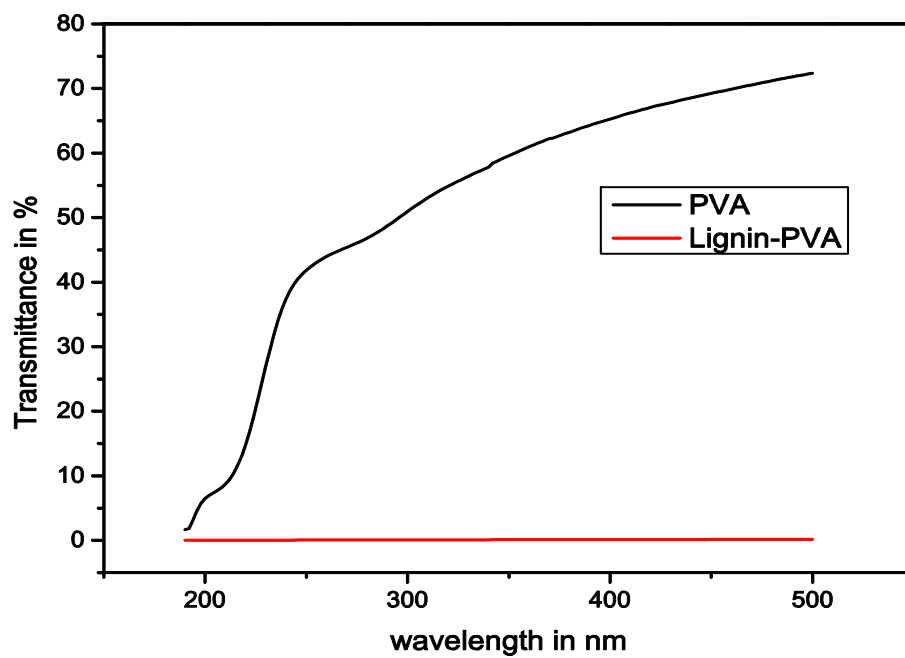


Fig5.5 Transmittance plot for lignin and composite film

Table 5.2 UV Shielding by lignin and composite film

S.no	Wavelength (nm)	PVA – Transmittance (%)	Lignin-PVA Transmittance (%)
1	250 (UV-C)	41.86	0.038
2	300 (UV-B)	50.94	0.0618
3	30 (UV-C)	59.57	0.088
4	500 (Visible)	72.338	0.148

The UV shielding effect for PVA and lignin-PVA composite film is represented in the fig and in table. As seen from the fig, the composite film completely shields the UV light and visible region of the electromagnetic spectrum. The composite film shows a negligible transmittance and meagre transmittance in the visible region.

5.1.5 SOIL BURIAL TEST

Soil burial test to check the biodegradability of film for that Have to take 4 Cm of tea cup in that fill the soil from bottom to 1.5 Cm then put the film into the soil after that fill the soil again 1.5 cm in that fully cover the film with soil, totally cover the 3 cm with the soil it gets a reaction, reaction happened in day-by-day basis.



Fig.5.8 Soil burial test

The biodegradability of composite film is presented in table. It has been shown that as the percentage of lignin content increases the biodegradability of the film also increases. The maximum biodegradability is achieved within 2-4 days with a maximum degradation of 61%. The composite film possesses hydrophilic nature hence not dissolved in water.

Table 5.3 Degradation of composite film

Film	Day0	Day2	Day 4	Day6	Day8	Day10	Day12
PVA	0.06	-	-	-	-	-	-
1: 9	0.1	30	30	30	30	30	30
2: 8	0.14	7.142857	7.142857	14.28571	28.57143	50	50
3: 7	0.12	41.66667	50	50	50	50	58.33333
5: 5	0.13	38.46154	53.84615	61.53846	61.53846	61.53846	61.53846

CHAPTER-6

SUMMARY AND CONCLUSION

Project aim is to derive lignin from rice straw to make bioplastic film for sustainable development from agricultural waste for that purpose first we prepare lignin and rice straw powder using 13g of choline chloride with 13 g of oxalic acid and 1 g of rice straw powder which gives lignin film then prepare lignin solution alone using NaOH 5 g, 0.5 g of rice straw powder, and 50 ml of distilled water after leave the solution for 1 hour in room temperature to get lignin solution, then prepared Poly vinyl alcohol solution by heating 100 ml distilled water after heating have to add 3 g of poly vinyl alcohol to get a solution, then prepare composite film using the ratio of lignin solution and PVA solution to get a film using petri dish after getting the film did a FTIR test and SEM test and XRD test and uv test and soil burial test for to know the quality and sustainability of film after getting all possible result finally make a sustainable bioplastic from agricultural waste of rice straw

REFERENCES

1. R. Harracksingh, ICIS Chemical Business, 2012,
<http://www.icis.com/resources/news/2012/07/02/9573828/bioplastics-surge-towards-commercialization/>, accessed 2015.
2. <http://www.plasticseurope.org/>, accessed 2015.
3. <http://www.plasticplanet-derfilm.at/hartefakten/hartefakten.html>, accessed 2015.
4. A. Weisman, *The World Without Us*, HarperCollins Canada, 2010.
5. <http://www.plasticstoday.com/articles/recycling-for-PET-packaging-reaches-31-percent-in-2013-141008>, accessed 2015.
6. M. Niaounakis, *Biopolymers: Reuse, Recycling, and Disposal*, William Andrew Publishing, 2013.
7. M. Vert and co-workers, *Pure Appl. Chem.* 84(2), 377–410 (2012).
8. European Bioplastics, 2012,
http://en.european-bioplastics.org/wp-content/uploads/2012/publications/Imagebroschuere_Dec2012.pdf, accessed 2015.
9. L. S. Arate-Ramirez and co-workers, *Carbohydr. Polym.* 112, 24–31 (2014).
10. W. He and R. Benson, in S. Ebnesajjad, ed., *Handbook of Biopolymers and Biodegradable Plastics: Properties, Processing and Applications*, William Andrew Publishing, 2012.
11. Google
12. Wikipedia