SYNTHESIS OF BIO BASED MATERIAL FROM FRUIT WASTE OF ORANGE PEEL

In partial fulfilment of the criteria for the award of the degree of Bachelor of Science in Chemistry, a dissertation was submitted to the University of Kerala.

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POSTGRADUATE AND RESEARCH

DEPARTMENT OF CHEMISTRY

BISHOP MOORE COLLEGE

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CERTIFICATE

This is to certify that the dissertation bound here with is an authentic record of the project work on "**SYNTHESIS OF BIO BASED MATERIAL FROM FRUIT WASTE OF ORANGE PEEL** " carried out by Nazrin Anees, Sruthi prasad, Swetha R, Nima SS under my supervision in partial fulfilment of the requirement for the award of the degree of Bachelor of Science of University of Kerala and further that no part thereof has been presented before for any other degree.

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DECLARATION

We hereby state that the dissertation, " **SYNTHESIS OF BIO-BASED MATERIAL FROM FRUIT WASTE OF ORANGE PEEL** ," is the result of original project work completed by under the guidance of Mrs. SILPA ANU MATHEW , Department of Chemistry, Bishop Moore College, Mavelikara, and it has never served as the foundation for the award of any other degree, diploma, or other title.

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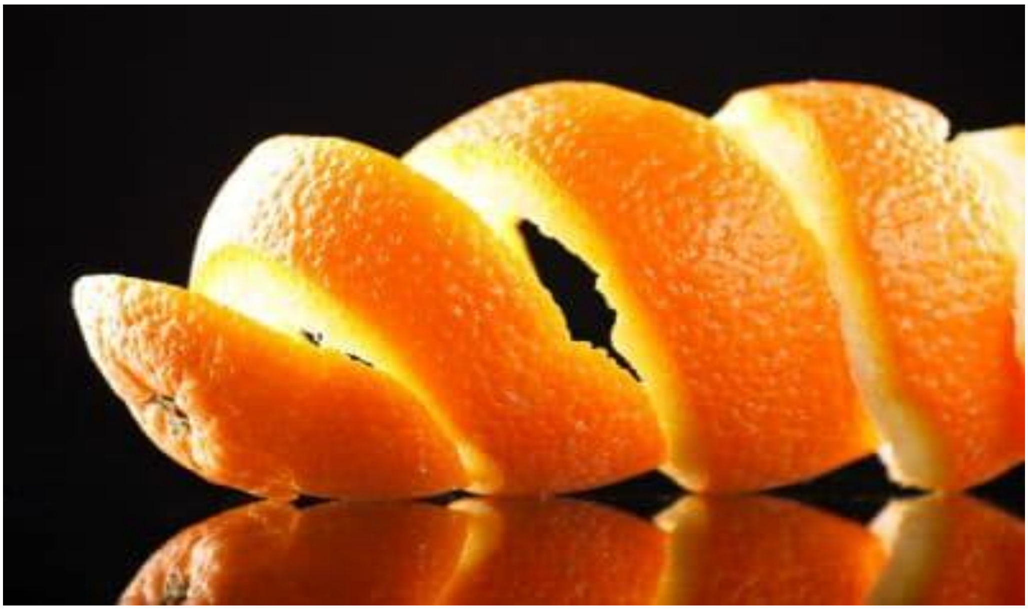
ABSTRACT

Bioplastics are made from renewable materials, including corn starch, sugarcane bagasse, and food scraps. Bioplastics, which are made from cellulose and starch, are already used for applications like packaging, cutlery bowls, and straws because they are entirely or partially biodegradable, making them less environmentally harmful than conventional plastics. However, their price and performance cannot compete with conventional plastics. The goal of the current study was to create bioplastic from food waste. Orange peel is therefore chosen due to its high cellulose content and easy accessibility. The bioplastic fibre made from orange peel was created in the lab using straightforward methods . The peels are first dried and ground into powder using a grinder and treated with glycerol and HCl before being thoroughly combined with distilled water and left for 48 hours before being peeled off. The biodegradability test and tensile strength analysis are done. The constituents of bio based material from orange peel is investigated using FTIR spectroscopy. This affirms the film's biodegradable nature and that its strength, flexibility, and disintegration under soiling circumstances due to its rough surface. The production of bio-based plastic is regarded as a straightforward, creative, and practical procedure.

SYNTHESIS OF BIO BASED MATERIAL FROM FRUIT WASTE OF ORANGE PEEL



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1.INTRODUCTION

Plastics are incredibly important in modern life. In terms of consumption, their yearly production is probably going to surpass 500 million tonnes by 2020.Plastics have established their value in emerging technology and medicinal developments. However, the majority of these plastics are currently released by the Indian government. It is still a major issue, and their consumption poses a serious harm to the ecosystem, the flora, and the animals. The accumulation of these dangerous chemicals in wildlife and humans is a major worry due to the chemical leakage from plastic items. According to one assessment, there are an estimated 5 trillion plastic pieces floating about in oceans from the Antarctic to the Artic of various nations. Potential green alternatives are urgently needed because of the environmental damage caused by plastics. Except when used as compost, food waste is intended to be an undesirable substance. Shrimp peels, orange peels and old coffee grounds are among the many food-derived wastes that are being transformed into bioplastic on a large scale. Areti Marko Polou and colleagues recently focused on integrating local food waste from urban environments and diverted fruit waste, which usually ends up in the land fill. Because main food waste sources like Spanish orange peels and Barcelona seafood have been successfully transformed into recyclable bioplastic. The material is typically gathered and sorted in food waste facilities, where bioplastic is produced

The manufacturing of environmentally friendly and sustainable machinery using a combination of natural and synthetic composites to satisfy worldwide demand and expand its market is an important future goal for the aerospace, automotive, construction, and wind turbine industries. Both the public and commercial sectors are currently contributing examples of funds to enhance the development of sustainable and environmentally friendly goods. In order to spread awareness of the value of these outstanding green composites for a variety of applications, scientists, researchers, and academics have found that green composites are typically made using biopolymers and bio fibres. The key to dealing with disposable solid waste is to effectively apply environmentally safe methods and practises to transform these waste materials into hazardous products, both beneficial and harmful. Depending on the basic requirements, the bioplastic can be produced, and it is simple to disseminate to the local inhabitants. According to earlier accounts, limonene is a naturally occurring component found in orange peels. Oxidation of limonene and its connection to carbon dioxide resulted in the manufacture of bio-based polymers, however the source of these materials is rather insignificant for various applications . Limonene and carbon dioxide react to form polycarbonates. As a result, it was said to not contain a dangerous chemical like b is phenol A. distinct as compared to common poly carbonates. The innovative bio-based polymers also offer a number of additional qualities that make them ideal for industrial applications .There are few papers that claim materials made from poly(limonene carbonate) (PL I m C)-based polymers do not also exhibit antibacterial activity by inhibiting E coli growth As a result, they can be applied to medical care and the creation of biodegradable implants These bioplastics are typically made out of renewable energy sources like algae, corn, starch, potatoes, tapioca, and sugar cane. According to their qualities, they are typically totally or partially biodegradable or compostable. However, processing issues with biobased plastics mean that they need polymer additives to increase their tensile strength and flexibility, but this will lead to fashionable, user-friendly items. The utilisation of natural fibres in the development of biodegradable materials, according to scientists. Orange peels are a particularly difficult type of food waste. Peels contain a lot of starch and pectin as well, a vital component in giving bioplastics strength Hemicellulose, starch, lignin, pectin, fat, and flavonoids are the main components of orange peels. Although the production of most biodegradable plastic results in a reduced carbon dioxide release compared to conventional alternatives, there are legitimate concerns as the orange peel decomposes to produce methane gas and contributes 20% of methane gas to global warming. As a result, it is imperative to utilise the solid waste of orange peels in the creation of a useful and beneficial product. If the issue is not resolved effectively, growth in the global bioeconomy may lead to an increased level of deforestation, which in turn adversely affects water supply and soil erosion. Since the current research effort is to provide a promising bioplastic that should have less or zero harm to the environment and likely have a low cost of production and availability as an alternative material to conventional and banned plastics based on the changing requirements of modern society, the development of bioplastics using waste materials is more relevant to the present perspective.

1.1 BIOPLASTICS

Bioplastics are defined as "plastic based on renewable resources or plastics that are biodegradable and compostable" by the European Bioplastics Organization (EBO). These bioplastics decompose naturally or when stimulated, primarily through the enzymatic activity of microorganisms, into CO_2, H_2O, organic compounds, or biomass.

The following four requirements must be met to qualify as a bioplastic polymer:

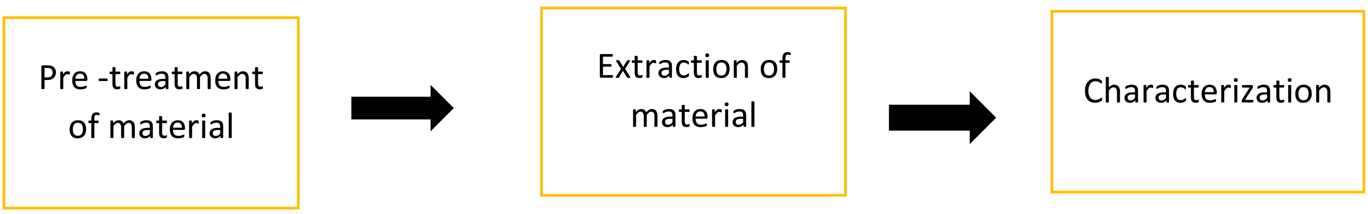
• Chemical characteristics: Organic matter must comprise at least 50% of the end composition.

• Biodegradation: Under conditions promoting composting, the developed polymer should degrade by at least 90% of its weight or volume in six months.

• Disintegration: Under controlled composting conditions, the bio-based polymer should, at the very least, fragment microscopic, undetectable components (2mm) within two months

• Eco toxicity: After biodegradation for six months, non-degradable biopolymer residues should not pose a danger to plant growth.

The biodegradable plastics are made of either natural or fossil sources and are biodegradable or mineralizable into water and carbon dioxide by the action of microorganisms, in a reasonable period of time. The term "Biodegradability" is defined as the characteristics of the material that can be microbiologically degraded to the final products of carbon dioxide and water, and therefore is unlikely to persist in the environment. Each material utilised, the properties of the bioplastic produced, and varied product configurations may all affect the bioplastic's production process differently. Each process is intricate and uses a multitude of techniques, components, and compositions depending on the material being processed. Pre-Treatment including processes such as grinding, drying, hydrolysing the material. Not all parts of the waste are used in the bioplastic manufacturing process, such as extracting only its starch and cellulose. And the most important part is characterizing materials such as adding plasticizer agent, odour controlling agent, and biological material.



1.2 CLASSIFICATION OF BIOPLASTICS

Plastics can be manufactured from bio-based or fossil-based materials and can be biodegradable or non-biodegradable. While bioplastics are only made from renewable materials, biodegradable plastics are made from fossil based or are made with mixture of renewable and fossil-based materials. Three types of Bioplastics are as follows: -

• Biodegradable and Bio-based.

• Biodegradable and fossil based.

•Non-biodegradable and petroleum based called as plastics

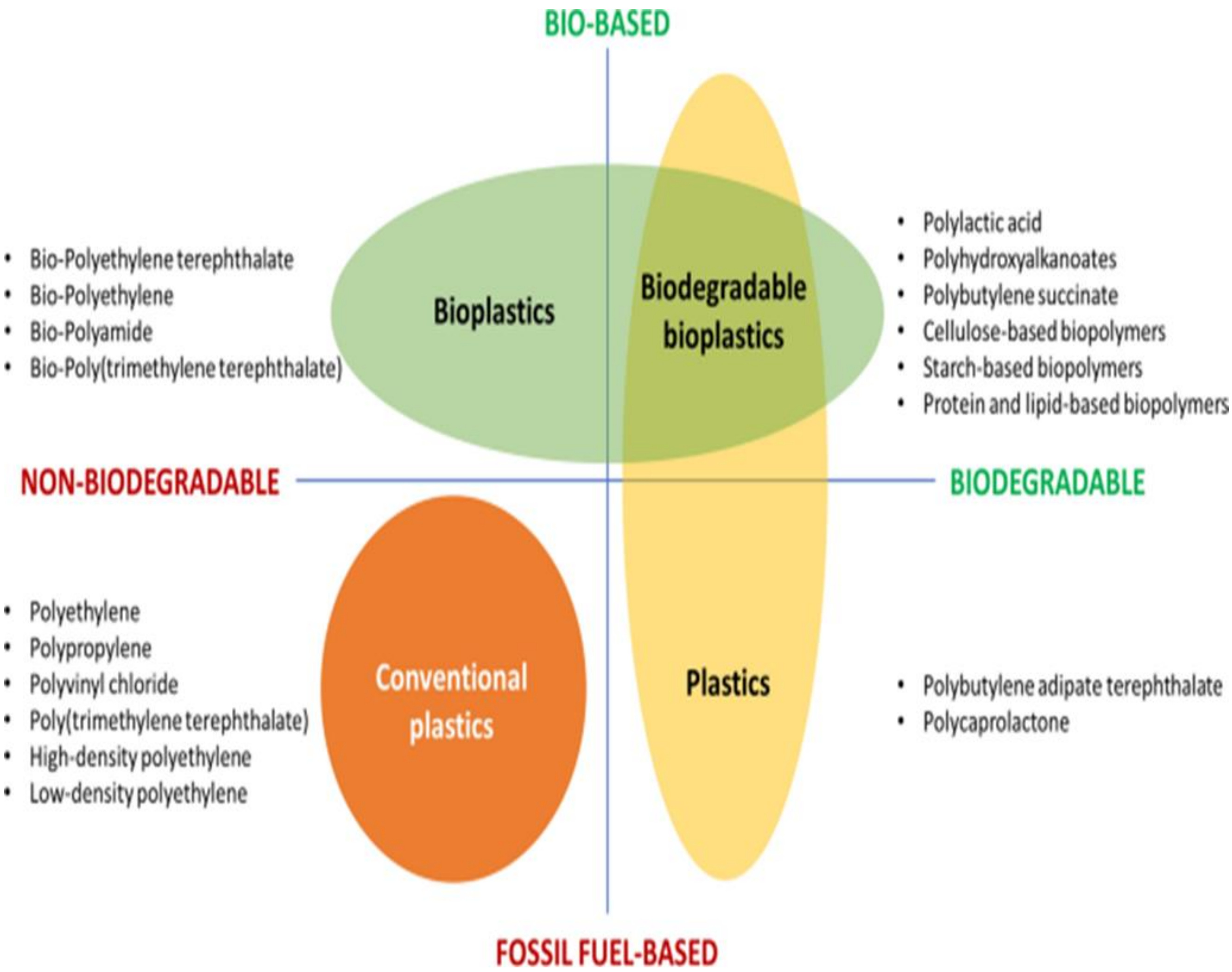


Fig1

1.3 PROCESS OF BIOPLASTICS PRODUCTION

The selection, processing, and modification of raw materials are just a few processes in creating bioplastics. Starch-based and non-starch-based materials are the two major groups into which the raw materials for the production of bioplastics can be divided. Because they are simple to make and have solid mechanical qualities, materials based on starch are frequently utilized to make bioplastics. Lignin and Cellulose, which are not based on starch, are being researched as potential raw ingredients for creating bioplastics. The extraction of the raw materials, followed by their alterations to produce the necessary qualities, is the first step in the manufacturing of bioplastics. This may entail physical alteration, such as introducing Nano fillers to increase strength and durability, or chemical modification, such as using plasticizers or crosslinking agents These are the main steps of bioplastic production:

Raw Material Preparation:

Bioplastics can be made from various sources, including corn starch, sugarcane, Cellulose, and vegetable oils. The first step in the manufacturing process is to extract and prepare the raw materials for use. Fermentation: In this process, the raw material is fermented, and the sugar in the raw material is converted to lactic acid.

Polymerization:

Lactic acid is polymerized into polylactic acid (PLA), a biodegradable and compostable plastic.

Moulding

The PLA is then moulded into the desired shape using injection, blow, or thermoforming techniques.

Completion:

After the bioplastic product is formed, the excess material is trimmed off, and the edges are smoothed and finished.

Quality Management:

The final step in the production process is quality control of the finished bioplastic product to ensure it meets the required specifications and standards. It is important to note that the specific details of the bioplastic manufacturing process may vary depending on the type of raw materials used and the desired end product

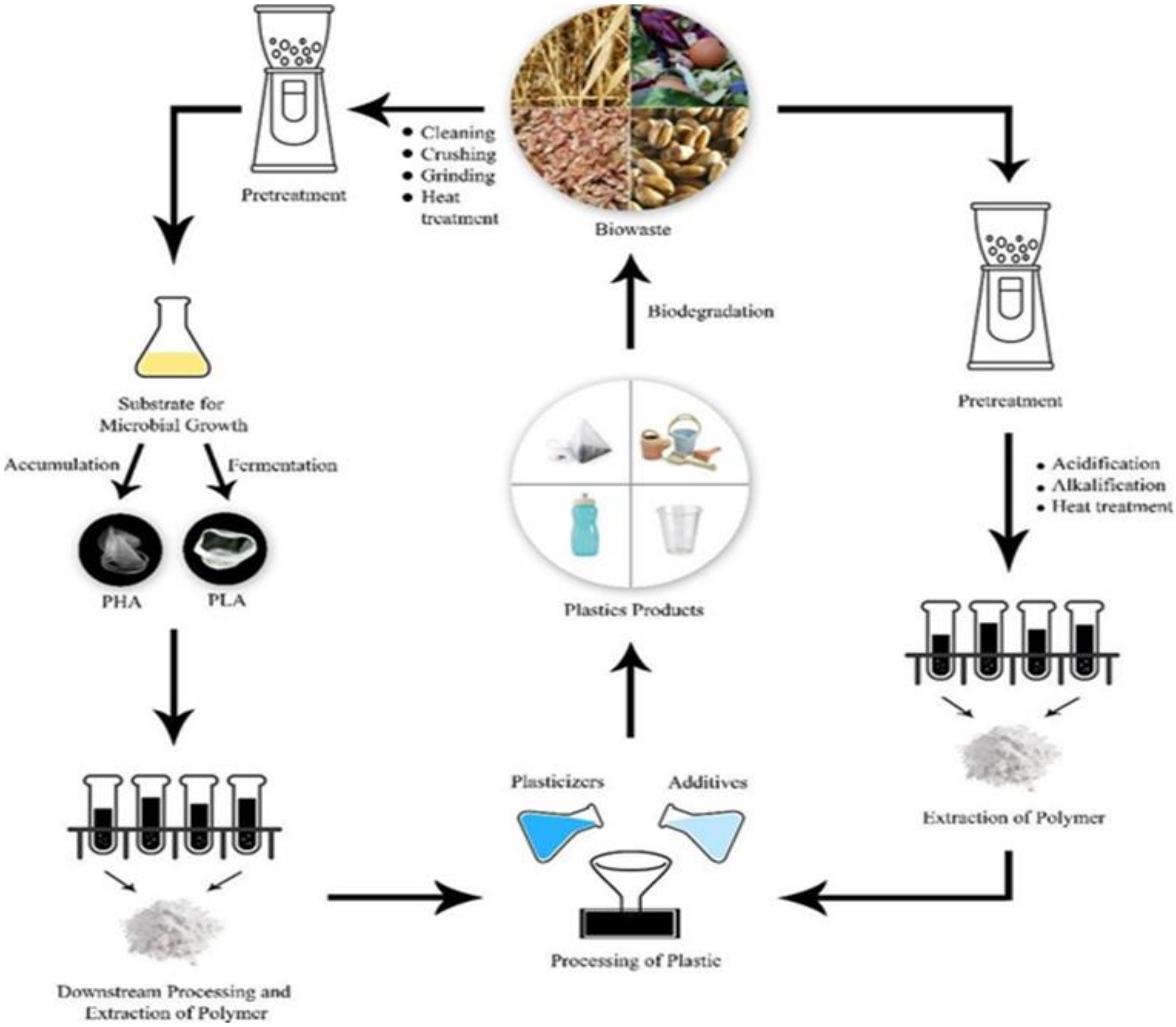


Fig.2

1.4 POTENTIAL OF FOOD WASTE AS BIOPLASTIC MATERIAL

- Sludge waste from food industry

The sludge that is freshly activated from wastewater treatment in a food processing industry can be used to make biodegradable plastic. Active sludge contains various types of microorganisms that can be used to produce PHB (Poly-b-hydroxybutyrate), produced by various bacteria as microbial polyester and stored in cells in the form of granules This material can be suitable for the synthesis of environmentally friendly plastics material . PHB production costs are very high, so the use of activated sludge is expected to be more efficient.

- Cassava peel

Because of its starch content, cassava peel is an agricultural waste that can be used as a bioplastic material. Starch is universal, renewable, and easily obtained so that it becomes potential material for bioplastic manufacturing . The study of making bioplastics from cassava peel starch has been carried out by combining the materials of starch and chitosan as a plasticizer by using sorbitol. The results showed that the best mechanical properties for bioplastics with a tensile strength value of 1.37 MPa was obtained at the addition of sorbitol 30% with a ratio of starch: chitosan (7:3).

- Banana peel

Banana peels as agricultural processing waste can be used in making bioplastics because they contain cellulose, starch, pectin, and other polymers. Cellulose is modified to obtain thermoplastic materials through acetylation (cellulose acetate). The use of pectin in making bioplastics functions as an emulsifier that increases intermolecular bonds in the film

- Pineapple peel

Pineapple peel is a waste that comes from household consumption as well as the pineapple processing industry. The main constituent of the peel is extracted as cellulose through refluxing with acid or alkaline solutions. Cellulose is a natural polymer, consisting of glucose units with a homogeneous chain structure. Cellulose can be converted to carboxy methylcellulose (CMC) through the etherification process.

- Jackfruit seed

Jackfruit seed, which constitutes 8-15% of the jackfruit, is potential food wastes due to its high starch content. It can be used for bioplastics production as raw material. A study on making bioplastics from jackfruit seed starch has been carried out.

- Durian seed

Durian seeds are waste from food processing as well as part of durian fruit that is not consumed because it feels slimy and itchy on the tongue. Even so, the seeds have nutrients including protein, carbohydrates, fats, calcium, and phosphorus. Carbohydrates in the form of starch in durian seeds have the potential to be used as material for making bioplastics. However, starch-based bioplastics have some disadvantages such as low mechanical strength and less resistance to water.

- Pomegranate peel

Has rich source of bioactive compounds. It consists of lignin-5.7% and hemicelluloses-10.8%, cellulose-26.2% and pectin-27%. On acid hydrolysis, the polysaccharides present in peel are converted into monosaccharides which can break down into cellulose, hemicelluloses and lignin components. These components further are used to develop bioplastic.

- Orange peel

The peel contains carbohydrates which can be used for the production of biomolecules. Careless discharge of unprocessed peels causes many environmental problems. Therefore, it is recommended to collect the waste and convert it into bioplastics.

1.5 DIFFERENT KINDS OF PLATIZICER USED IN PRODUCTION OF BIOPLASTIC

Plasticizers are organic molecules, that are added to polymers, to reduce brittleness, reduce crystallinity; improve durability, toughness; lowering melting temperatures. These reduce polymer-polymer contact hence the rigidity.

of the 3D structures is also reduced, allowing deformation without rupture. In the production of bioplastic, different kind of plasticizers are used that includes polyols such as glycol, glycerol, sorbitol, fructose, sucrose, and mannose, fatty acids such as palmitate or myristate. Out of these, glycerol is most widely studied and used plasticizer because of its non-toxicity, low cost and high boiling point(292°C) properties,

1.6 APPLICATIONS

- Bioplastic can be utilised in the production of shopping bags.
- Sony has switched to bioplastics for its new staff ID cards. Therefore, it is clear that it can be expanded into widespread practises.
- The bioplastics can be used to create utensils.
- It is employed in the Toyota facility to produce auto parts.
- These plastics are also utilised in non-disposable products like plastic pipes, carpet fibres, car interior insulation, and phone casings.
- Disposable pots, bowls, foil for hamburger packaging, straws, and cutlery are all made from bioplastics.
- It is used for coatings and adhesives.

1.7 ADVANTAGES

Benefits of using biodegradable bioplastics for waste management

To limit the quantity of plastic trash produced by society, grocery store chains, the food service business and the agricultural sector have successfully implemented bioplastic packaging. Managing biological waste is made simpler by biodegradable plastics.

Bioplastics' carbon neutrality

Since global warming has become a significant worry, bioplastics have gained more attention as a way to reduce society's overall carbon dioxide (CO_2) emissions. Whereas making regular plastics necessitates the net addition of carbon to the atmosphere, the CO2 released by BPs originates from biomass. It may therefore be carbon neutral throughout its existence. Even if the BPs feedstock may be carbon-neutral, bioplastics processing may still be powered by fossil fuel.

Possibility of a much smaller carbon footprint

It should be noted that whether or not a bioplastic permanently stores the carbon drawn from the air by the growing plant significantly impacts its carbon footprint. A synthetic material derived from living organisms sequesters the CO_2 the plant takes during photosynthesis. This sequestration is undone if the resulting bioplastic reverts to CO_2 and water. However, a permanent bioplastic that resembles polyethylene or other common plastics can permanently store CO_2. The CO_2 initially removed from the atmosphere is still trapped in the plastic, even after it has been recycled numerous times.

Reduction in energy use (Less Petroleum Dependence)

Possible petroleum shortages are now a significant worry. Compared to the production of conventional plastics, the production of bioplastics uses less fossil fuel. Multilayer films made of polylactic acid had a life cycle assessment revealed their environmental impact was almost half that of films made of petroleum.

Manufacturing will pay less for energy

Nevertheless, just 4% of the oil consumed worldwide yearly is used to make plastics. Plastic production is more vulnerable to price fluctuations due to the lack of oil.

Avoid using limited crude oil

In comparison, producing one kilogram of plastic often takes more energy than producing one kilogram of steel or 20 kilowatt hours. About all of this is derived from fossil sources

Reduction of CO_2 emissions

Between 0.8 and 3.2 tons less carbon dioxide is produced per ton of bioplastics than petroleum-based plastics

Utilizing biodegradable bioplastics results in a decrease in litter and an increase in composability. The decrease in the persistent litter is the benefit of biodegradable bioplastics that is most understood.

Benefits for rural economy

As nations worldwide hunt for alternatives to oil to protect the environment and achieve energy security, the price of crops like maize has increased significantly. This is because a growing interest is in manufacturing biofuels and bioplastics worldwide

1.8 DISADVANTAGES

<u>High Production Cost</u>

The cost of producing bioplastics is higher than that of traditional plastic. If the usage of bioplastics on a large industrial scale spread, it will likely result in cost savings. The cost of producing bioplastics is more than twice as high as that of ordinary plastics. Several studies have supported this assertion.

<u>Bioplastics have weak mechanical properties</u>

Packaging materials comprised of starch and cellulose-based plastics have low long-term stability, poor processability, brittleness, and inferior mechanical properties because of their hydrophilic nature. The limited mechanical strength of bioplastics frequently restricts their use. It uses other environmentally hazardous components such as carbon, glass, nano clay, fibre, and nanoparticles.

<u>Uncertainty among consumers</u>

Most bioplastics' labels and identifications do not give customers enough information. This creates uncertainty and makes it challenging to handle bioplastics correctly. This results from the manufacturers' inadequate information delivery

<u>The stockpiles of raw materials used to make bioplastics can decline</u>

In order to reduce energy consumption during the production of bioplastics, prevent potential competition with agricultural resources for food, and provide new sources of raw materials, it is also becoming more popular to utilize food by products.

<u>Isolated Recycling</u>

A contamination issue may be if bioplastic material is recycled with regular plastics.

<u>Toxins can be formed</u>

Toxic can be released from degraded substances

1.9 THE LIFE CYCLE OF BIOPLASTIC

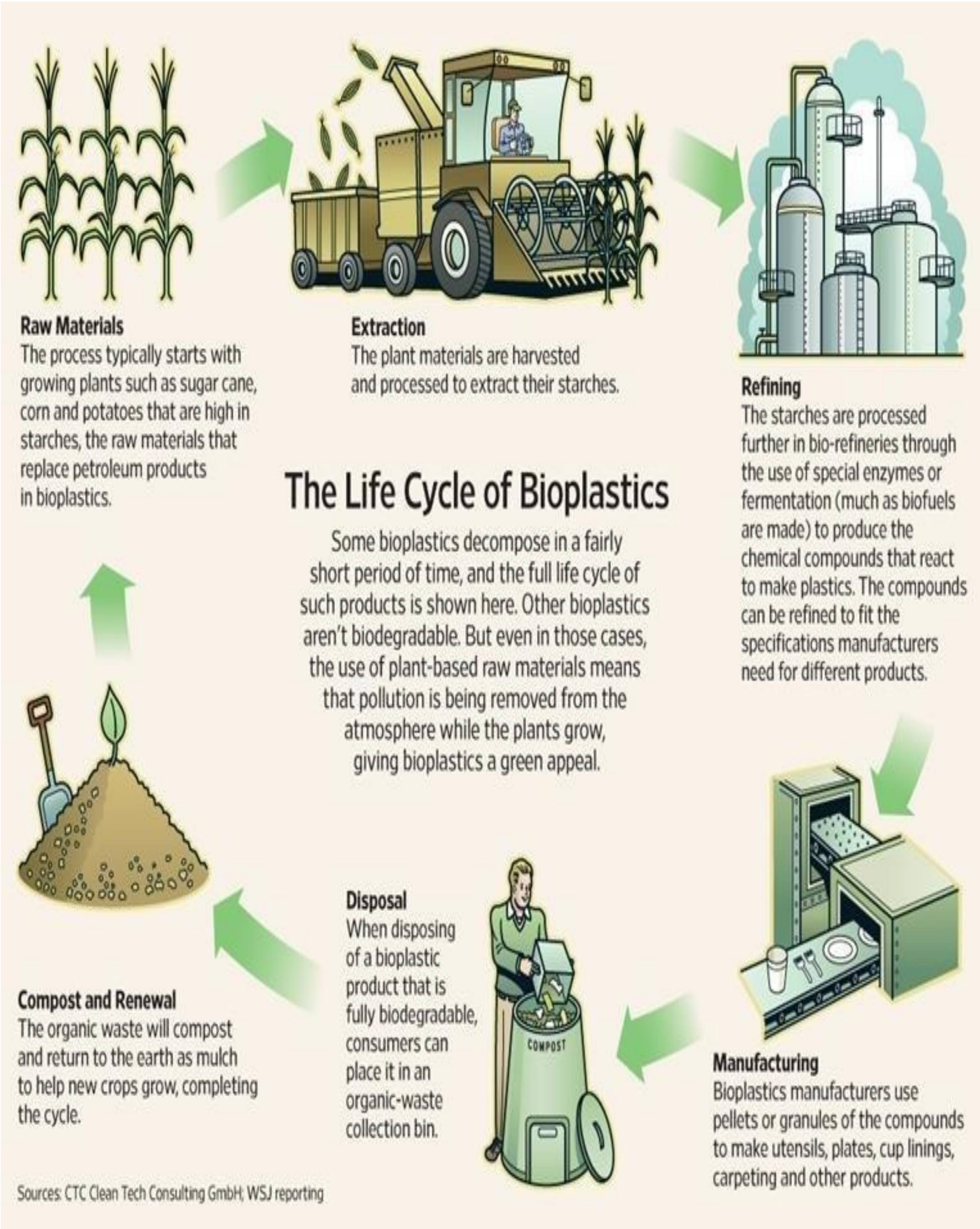


Fig.3

Scope of the work

Bioplastic has been emerged as one of the most innovative and eco-friendly materials developed in the past few years. Though bio plastics are gaining renowned attention as a promising replacement of chemical based conventional plastics, there are some hindrances that needs to be addressed in this regard. This mainly includes improvement in mechanical properties such as heat-resistance, and shock resistance and processability, advancements in manufacturing technologies, expansion of applicability, establishment of standards and reduction in the cost of production. Current research in this field is focused towards resolving these issues. The mechanical properties can be improved by investigating better plasticizers and developing composite polymers rather than sticking to a particular type of polymer. This would help to expand the application of these plastics in different sectors. In addition, a wide range of biological sources specifically waste products, needs to be screened for making the process cost effective. These efforts would lead to rapid expansion in the bio plastic industry.

2. REVIEW OF LITERATURE

S. Veena and M. Rani successfully created bioplastic from banana peels and tested its biodegradation by microorganisms. The banana peel is boiled for 30 minutes, allowed to dry, and then blended into a homogenous paste with a mortar and pestle. To 25 grams of banana paste in a beaker, two millilitres of glycerol and 0.5 N HCl were added. The mixture was poured into a glass petri dish and cooked at 130°C until dry, then the plastic film was scraped off the top. After noting the biodegradability and rate of degradation of the created biopolymer, experiments with microorganisms are carried out. which comprises the method of serial dilution, Streak-plate technique and Technique for gram staining This process could result in significant amounts of bioplastic that are also biodegradable. In addition, the fabrication of bioplastics is made possible by microorganism biotechnology, which has great potential applications in a number of sectors, including agriculture, medicine, pharmaceuticals, veterinary care, and others.

Michael Ladenburg and J.P. Gustafsson synthesised bioplastic from apple pomace (AP) produced by Lyckens apple (Bredared , Sweden).Other materials in the study were orange pomance, glycerol and citric acid monohydrate The motorised apple crusher first processed fresh apples by grinding them into smaller bits. After that, the apple mush was put into a hydropress with a rubber membrane. The membrane forced the mash against the sieve walls after it had been filled with water, pressing the juice out. The residual product, the AP, was gathered and sent to the project's researchers, who kept it in storage at -20 °C until it was needed. Using a variable-speed rotor mill, the dry AP was ground to sizes of 1.0 mm and 0.2 mm to get this fine powder. A square form was filled with AP powder with a size of 1.0 mm or 0.2 mm, either washed or not, with glycerol

(GLY) in the range of 0–40% (w/w). A 10-tonne or 20-tonne manual compression n may be used, depending on the amount of force that would be exerted on the sample. It was done with a moulding press that was heated to 100 °C. Apple pulp is used to create a 3D bioplastic substance. similarly, Compression moulding can also be used to create 3D bioplastic materials from a mixture of orange and apple pomace The self-binding ability of biopolymer is noted. Bioplastic cups are made from apple pomace. Analysis of the mechanical properties of bioplastic materials from pomace is carried out. The tensile strength of both materials is noted. The effects of pressure, time for compression, particle size, and glycerol content on washed apple flavour are noted. Production of bioplastic films from apple pomace by casting is done. Highest values in terms of tensile strength and elongation at max for the compressed materials was reached with a mixture of washed apple pomace and glycerol. but similar properties are obtained using apple pomace alone. Orange waste can be added to the apple pomace to increase the tensile strength at the expense of the elongation at max.

For industrial purposes, Jayachandra S. Yaradoddi and his colleagues created bio-based material from fruit waste, specifically orange peel. Orange peels from the Citrus sinensis variety were gathered and stored in the refrigerator at a temperature of around 15 °C until usage. An orange peel pestle and mortar were used for the pulverisation process, and they were heated to 120 C for 10 minutes in a hot air oven. 25 g of the material are combined well and uniformly with 3 ml of 0.1 N HCl and 1.8 ml of glycerol before being completely crushed with a pistil and mortar. The uniform paste was then poured into the moulds for the desired shape and part of the sample cast on the glass slab and room temperature for about 48 h. After the incubation time, the sample is peeled off from the glass slab/moulds. Different characterization are done including biodegradation water and oil permeability test. FTIR, ,TGA,SEM,XRD is done to know about functional group present and surface morphology. he FTIR spectra of orange peel were observed in the region of450-4000 cm-1Micro tensile analysis is also done. The bio-based material obtained is promising, although further characterization and improvements are necessary to achieve the desired features such as hydrophobicity.

Manasi Ghamande and coworkers synthesised DIY bioplastic from orange peels. This is created by combining four oranges and 25 grams of coffee grounds. All of the oranges' peels were first removed, and they were kept in the pot. After that, water is poured in and heated. The peels were then removed and ground after that. Then, a bowl containing 15 ml of water, 25g of tangerine peel, 25g of corn starch, 2g of sodium bicarbonate, 5 ml of lemon juice, 5 ml of sage oil, and 5 ml of vinegar is filled with the powder that has been created and heated. After heating, a bowl-like shape appears. and placed in a microwave for three to four minutes. At second time, we made the bioplastic bowl using orange peels and ground coffee both.Procedure for both are same The team performed a series of material experiments on the bio-plastic to understand how and to what degree the material would transform when subjected to various strains and stresses. The DIY bioplastic project really helps in reducing the use of biodegradable and non-biodegradable plastic. Also there are only few limitations of this project and we get the best benefits by using this bioplastic.

Nonni Soraya Sambudi and coworkers Modifide Poly(lactic acid) with Orange Peel Powder as Biodegradable Composite PLA, Sweet orange (Citrus sinensis) Chloroform Hydrochloric acid , Sodium hydroxide , Deionized (DI) water are used for the experiment The chemicals are utilized without further purification or treatment Sweet orange (Citrus sinensis) peel collected , washed with and dried under the sun for 20 h, followed by drying in oven for 18 h at 60 ◦C . Dried orange peel was then crushed using pestle and mortar, then milled into finepowder using electric blender. The powder was sieved and then stored in plastic container at room temperature until use. PLA pellets were dissolved in chloroform under constant stirring for 1 hr at room temperature to make 10 wt% PLA solution. Around 0.5 g orange peel powder was added into the PLA solution and stirred for another 1 hr to prepare. The solution was casted onto flat glass plate and four petri dishes, respectively and dried for 24 h at room temperature The morphology of film was captured by using stereoscopic microscope .The sample functional groups were characterized using FTIR PLA sample of size $2 \times 2\ cm^2$ was placed and the intensity of transmitted light was computed in a wave range of4000–500 cm−1. Swelling and biodegradability tests were conducted. Mechanical properties and degradation rate is noted. It was proven that OPP has been incorporated into the PLA matrix by the presence of hydroxyl group in the high energy region, and C=C functional group at wavenumber 1608 cm−1.Moreover, it was found that addition of OPP into PLA has generally decreased the tensile and modulus, but significant increase of elongation was observed at low loadings of OPP.

Syaubari, Abubakar, and coworkers synthesised and characterized biodegradable plastic from watermelon rind starch and chitosan by using glycerol as plasticizer Watermelon rind is a part of the watermelon that is rarely used, less application of polymer materials which has the potential to produce starch. . Chitosan and lemongrass were chosen to combine with watermelon rind to increase its tensile strength. Glycerol was used as a plasticizing agent because it could be fully dissolved in starch solutions and other organic materials. For this case of study in watermelon, rind starch was produced by the extraction method, the yield makes up to 0.07%. Bioplastic films can be obtained by adding plasticizing agent and amylose/amylopectin, but this study is evaluating the differences between each combination of additives with different compositions. Therefore, conducted some analysis of Tensile Strength, FTIR, Scanning Electron Microscopy, and Biodegradation for this study. Sample starch +0.5 ml glycerol+0.75 g chitosan, has the highest tensile strength value of 52 MPa, and the highest elongation value was found in the starch + glycerol 0.5 ml sample which was 14.2%. The effect of combined lemon grass oil influences the degradation process, resulting in a long time in the degradation process than other samples Watermelon rind is successful in producing starch to make biodegradable plastic with a yield value of 26%

3. OBJECTIVES

THE PRIMARY GOAL OF THE EXPERIMENT IS TO:

- Synthesis biobased material from orange peel fruit waste
- Determine its tensile strength and biodegradability
- Determine the chemical constituents of biobased material from orange peel using FTIR.

4.MATERIALS AND METHODS

4.1 MATERIALS

4.11 APPARATUS REQUIRED

- BEAKER
- GLASS ROD
- WEIGHING MACHINE
- GRINDER
- STANDARD MEASURING JAR
- WASH BOTTLE

4.12 CHEMICALS REQUIRED

- 0.1N HCL
- GLYCEROL
- DISTILLED WATER

4.13 INSTRUMENTS REQUIRED

- FTIR SPECTROMETER

IR spectroscopy has been a workhorse technique for materials analysis in the laboratory for over 70 years. IR spectroscopy is a powerful method for the identification of functional groups. Because each different material is a unique combination of atoms, no two compounds produce the exact same IR-spectrum. The size of the peak in the spectrum is an indication of amounts of material present. The most important region of IR-spectrum are greater than 1650cm^{-1} whereas the finger print region of the spectrum cannot easily be used for identification of unknown compounds.

The FTIR spectra of bioplastics film obtained from orange peels were recorded in SHIMADZU-8400 spectrometer using KBR pellet method. The FTIR spectrum of the sample was obtained at the wavelength in the range of 450- 4000 cm^{-1}

4.2 EXPERIMENTAL METHODS

Collection and processing of fruit waste of orange peel

The gathering and preparation of fruit waste made from orange peels

To maintain a consistent source, orange peels from the navel variety of orange were procured from Mavelikara's local market in Kerala, India. Before usage, the gathered orange peels are kept in the refrigerator at a temperature of around 15°C

Production of bioplastic filim

In order to separate the polymeric components from the orange peel, pulverisation using a pestal and mortar, a mechanical disruption approach, was carried out. The orange peel was dried under hot sun for about 20 hrs, followed by drying in hot air oven to eliminate the surplus moisture. An additional 25 grams of orange peel paste were taken for processing. 3 ml of 0.1 N HCl was added to the sample, agitated with a glass rod, followed by 1.8–2 ml of glycerol, mixed thoroughly and uniformly with distilled water, and totally squeezed with a grinder .A portion of the sample was cast on a Teflon plate and left at room temperature (RT) for around 48 hours .The sample can be removed from the plate after incubation. To ensure the experiments could be repeated, every preparation step was carried out three times.

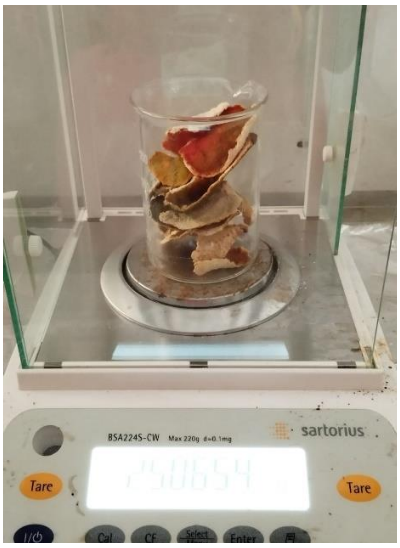


Fig.4

Fig.5

Fig.6

Fig.7

Fig.8

4.3 CHARACTERIZATION

4.3.1 Biodegeadation

The biodegradation of the plastic was carried out using the soil burial method, which involved taking two paper glasses and filling them with soil to the top. Preweighed 0.5-grams chopped foils were placed at a specific depth on paper glass and reported as an initial weight prior to soiling conditions. To examine the impact of moisture content on sample degradation, one of the film samples was sprayed with water while the other was left dry. The weight drop of the sample is likewise seen after a week of observation with these two samples.

4.3.2 Mechanical analysis

The tensile test was carried out in accordance with ASTM D882, a standard procedure for analysing the mechanical characteristics of thin plastic films with a thickness less than 1 mm. The sample size for analysis was 1 cm in width and 10 cm in length. The tensile test shows how much force is needed to break the bioderived plastic as well as how far the sample has stretched and elongated before it breaks, which aids in determining the mechanical strength that the sample can support.

4.3.3 Procedure of UTM

A Universal Testing Machine (UTM) is a type of mechanical testing equipment that is utilized for determining the mechanical properties of various materials, such as tensile strength, compressive strength, bending strength, and shear strength. The UTM works by applying a controlled tensile or compressive load to the specimen being tested and measuring its response. The UTM machine comprises two primary components: the loading frame and the control panel. The loading frame is responsible for applying a load to the specimen, and the control panel is utilized to set the test parameters and record the test results. To begin the testing procedure, the specimen is first prepared according to specific standards for the material being tested. Next, the specimen is placed into the grips of the loading frame, which can be adjusted to securely hold the specimen.

To perform the test with UTM, the sample is placed between the two jaws and clamped firmly to perform either tension or compression test. Once the sample is placed in its right position, the jaws are pulled apart to apply tension on the sample. The tension is applied to the sample until it reaches the fracture point. Once the testing process is completed, the machine automatically stops, and the test results are displayed on the control panel. The results usually include the maximum load the specimen can withstand before failure, the deformation or strain at the point of failure, and the modulus of elasticity of the material.

Aside from mechanical properties testing, UTM machines are also capable of performing other testing procedures, such as compression testing, flexural testing, and shear testing. In conclusion, the UTM machine is an essential tool for determining the mechanical properties of materials. Its working procedure involves subjecting a specimen to a controlled load and measuring its response, which provides valuable information for material design and quality control

Fig.9

5. RESULTS AND DISCUSSIONS

5.1 BIOLOGICAL DEGRADARTION

The biodegradation test was conducted to understand sample degradation in the soil concerning time, since microbial activities. For the soil microbial activity, moisture content plays a crucial role in enhancing the sample's degradation Therefore, two separate tests considered understanding the mechanism of biodegradation of the sample. In one experiment, a sample with moisture content (sample A) and another test sample in the absence of extra moisture (sample B) kept for 1 week. Biodegradation of bioplastic can vary from weeks to mo0nths depending on the material used .Two samples are kept in well ventilated area with sufficient sunlight. The sample A is watered 2-3 times a day ie. It is kept moisture locked on the other hand sample is left dry. After a week it is noted that sample A is almost degraded while little change is observed in sample B The constituents such as starch, pectin, and cellulose present in the orange peel provide much-desired carbon sources for the growth and multiplication of microbes. Soil microorganisms produce extracellular hydrolytic enzymes. Enzymes such as pectinases, cellulases, hemi cellulases bind to pectin, cellulose, hemi cellulosic contents respectively and initiate microbial biodegradation of the film . Hence, results showed biodegradation occurs faster in the existence of extra moisture content than degradation in natural conditions By these results, we can conclude the bioplastic produced using orange peel of navel variety degrades nearly within one week

Fig.10

Fig.11

Fig.12(A)

Fig.13(B)

5.2 TENSILE STRENGTH

The bioplastic film's mechanical strength is mainly based on the chemical constituents, structure, and film-forming ability. The formed film's micro tensile strength and elastic properties were determined. It is noted that bioplastics made from various types of starch with glycerol plasticizer without filler has a tensile strength of range 0.22-18.49Mpa. Accordingly, the tensile strength of orange peel-based plastic was 1.72 MPa However the modulus of elasticity of the bioplastics is found to be 54.68Mpa After vigilant interpretation of the results, we can conclude that the bio based plastic film developed using orange peel can exhibit higher elongation properties if its modulus of elasticity can be lowered

ASTM D 882 : Standard Test Method for Tensile Properties of Thin Plastic Sheeting   Thickness [mm]   Tensile strength

	Thickness [mm]	Tensile strength [MPa]	Maximum Load [N]	Load at Break [N]	Yield Strength [MPa]	Young's Modulus [MPa]	Elongation at Break [%]
	1.01	1.71	17.8054	0.46	1.7629	53.95	17.60
1	1.02	1.73	18.6036	0.15	1.8239	55.42	13.14
2	1.02	1.72	18.2045	0.30	1.7934	54.68	15.37
Mean	0.01	0.01	0.56	0.22	0.04	1.04	3.16
Std:deviation	0.70	0.63	3.10	73.39	2.40	1.90	20.54
Coeff:of variation							

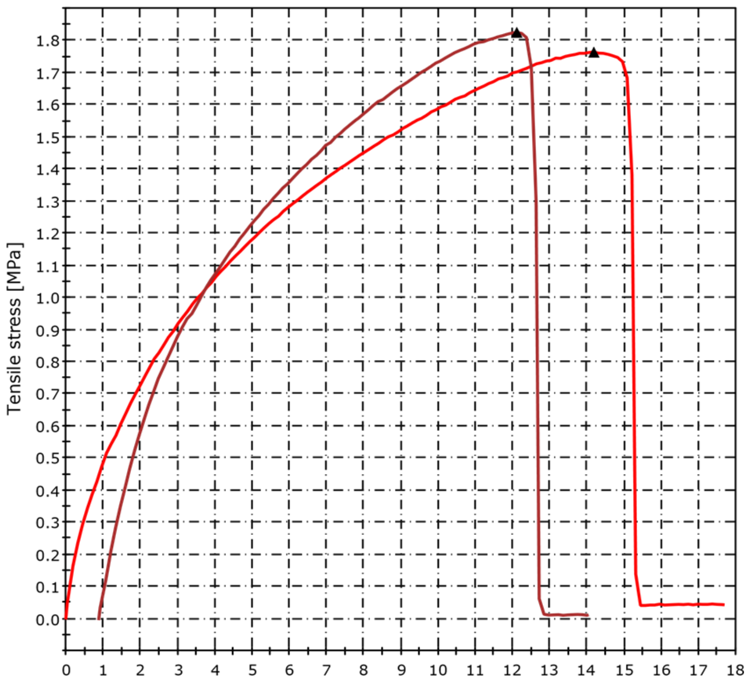


Fig.14

5.3 FTIR ANALYSIS

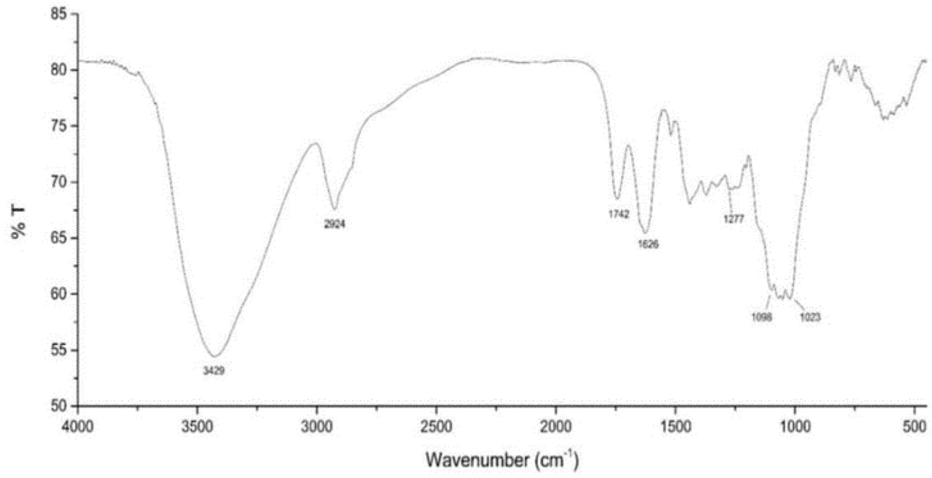


Fig.15

FTIR measurements for synthesized bioplastic film were carried out to identify the possible biomolecules present in the bioplastic. The result of FTIR analysis of synthesized bioplastic shows as follows: The stretching absorption band centred at 3429 cm–1 represents the OH group. The band observed at around 2924 cm-1 showed carboxylic acids . The peak at 1626 cm–1 is assigned to the C=C stretch of alkene, aromatic or amino acids The band at 1742 cm-1 is related to carboxylic group of esters. The peaks at 1098 cm-1 and 1023 cm-1 are due to the C=O stretching and are characteristic bands of cellulose. The above results are found similar to the report of Pranav et al. which confirms the presence of biomolecules such as alcohol, amine, esters, and carboxylic groups in orange-based biomaterial.

The above results are found similar to the report of Pranav et al. which confirms the presence of biomolecules such as alcohol, amine, esters, and carboxylic groups in orange-based biomaterial. The orange peel waste contains mainly cellulose, pectin, lignin, hemicellulose, and they are inevitable sources for renowned biomaterials synthesis. As per the Fig. 15 the peak of 2924 cm-1 belonged to carboxylic acids The main source of presence of carboxylic acid in the developed material are cellulose or pectin or lignin. The analysed film sample also contains amino acids 1626 cm-1 stretching and pertaining to their orange peel derived film can also used for the protein synthesis through biological process. Besides, this the hydroxyl groups in the film sample plays critical part in adsorption of anionic dye impurities. One of the significance observations was made that there were no peak seen between 2220 and 2260 cm-1 which is directly corresponding to the cyanide groups, that certainly confirms that the developed material do not comprise any hazardous materials. The presence of amide, amine and amino groups in the sample indicated they serve as very good sources of nitrogen.

6. CONCLUSION

The bio-based material produced in the experiment demonstrated good biodegradation with a high moisture content. Biodegradable bioplastics can be just as durable as other bioplastics, as they only disintegrate in specified situations. The tensile strength of the material is determined to be 1.72 MPa, which is in the range of bio plastic created from various types of starch with glycerol plasticizer. . According to JIS standards, 1–10 MPa is the ideal tensile strength value. An orange peel-based bio-based substance is therefore thought to meet JIS standards. The modulus of elasticity is discovered to be higher, nevertheless. Therefore, we can draw the conclusion that the material's flexibility can be enhanced by lowering its Young's modulus. It is also claimed to be a noteworthy research because the methodology adopted demands the naturally available resources that to organic waste materials like orange peel and that can be converted to wealth technology. The FTIR analysis was conducted to know about the presence of functional groups in the film, Moreover, it is realized that there are no harmful constituents present in the material. Thus, the developed material is safe to the environment. The presence of carboxylic acid dictates their role in pharmaceutical applications. The presence of the plasticizers has made the film more tangible material. he foremost essential constituent of the biobased plastic, i.e., pectin and cellulosic fibres, provided the required strength and also ensured biodegradability could be used as short-term packaging material. The bio-based material obtained is promising, although further characterization and improvements are necessary to achieve the desired features such as hydrophobicity. Lastly, bio-plastic production from orange waste can serve as an excellent solution to the challenges raised by the disposal of fruit waste and its effective utilization is highly concern

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