Synthesis Of Biodegradable Plastics Using Potato Starch

PROJECT REPORT

Submitted in partial fulfillment of the requirement to

RGUKT RK VALLEY

For the award of the degree of

BACHELOR OF TECHNOLOGY
in
CHEMICAL ENGINEERING
by

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2022-2023

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CERTIFICATE

This is to certify that the Project Report entitled

"Synthesis Of Biodegradable Plastics Using Potato Starch "

is a bonified record work done by **S.ARSHIN(R180043), G.PRANATHI SRI REDDY(R180113)** in partial fulfillment of the requirements for the award of

"Bachelor Of Technology In Chemical Engineering"

during the academic year 2022-2023

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Acknowledgement

We are pleased to acknowledge our heart fully thanks to our project guide **Miss.G.Sowjanya,** Assistant professor in the Department of Chemical engineering for her guidance, frequent advices, valuable suggestions and encouragement to complete this project.

We whole heartedly thank **Dr.M.Suresh Kumar ,** Head of the Chemical Engineering Department.

We also wish to acknowledge our deep sense of gratitude to **Dr.K.Sandya Rani,** Director for her help in the completion of this term paper with in the college premises.

We sincerely thanks to **V. Ramasubbaiah**, **M.DSVJP Koteswari**, , **Dr.Vivek Kuma**r , **Dr. R.Lakshman Naik**, **Dr.Chandrasekhar**, Department of chemical engineering RGUKT RKV for offering their valuable guidance and encouragement through the course of this study and spending their valuable time for us.

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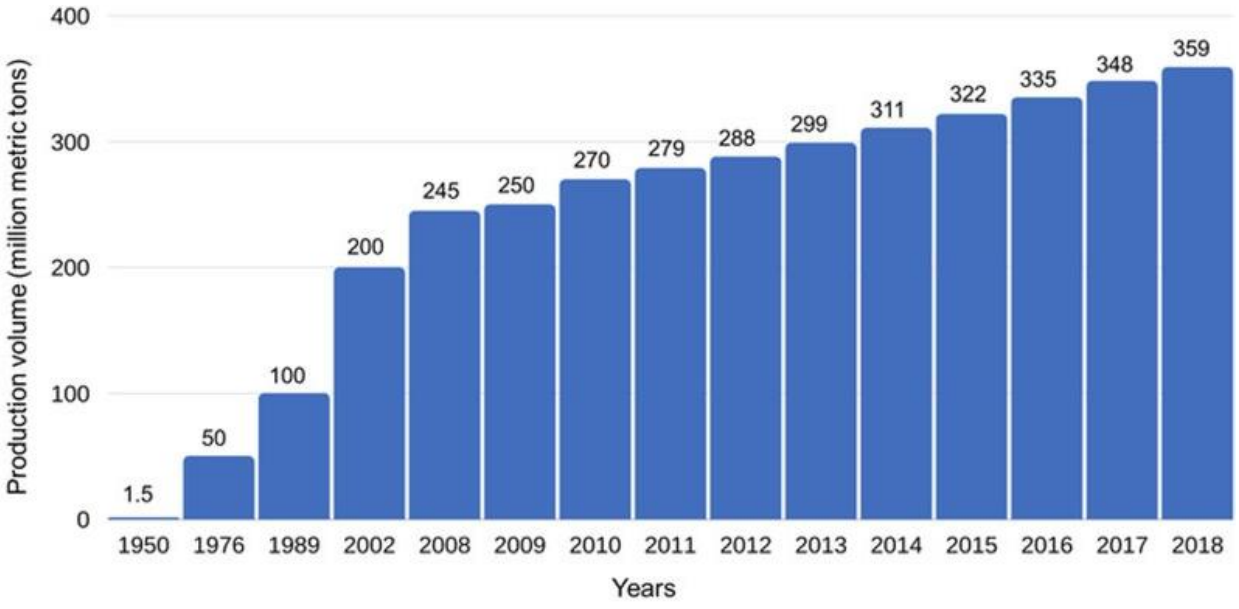
Contents

Abstract

Bio plastics are polymers prepared from renewable materials . In this study potato starch is the base material. At first we prepare some amount of potato starch from potato. The ingredients required biodegradable plastics using potato starch , distilled water up to 1 liter , some amount of starch , vinegar , glycerin . Taking small Blow making the mixture of 100ml of distilled water , 20g of potato starch, 12.8g agar , 8ml vinegar , 2mL Sorbitol and 8ml glycerin. Taking a Medium bowl and fill with 150ml of distilled water and keep it on the burner respectively place the prepared mixture on the bowl . At the medium flame stir the mixture slowly for 8 min to 10 min . Mixture is converted to semi solid and then we can structure the plastic.

Chapter-1
Introduction

The ingenuity behind inventing plastic was considered as a ground breaking innovation when it first came into widespread use in general goods and jewelry in 1920s. The diversity and adaptability of plastic has made it as a day to day life product in almost all over the glove. However, plastic is mainly a petrochemical-based materials which is a non-biodegradable product. So it has raised environmental concerns and hence, the driving force in the search for 'green' alternatives for which starch remains the front liner. Starting from the morning till going to the bed, plastic is almost everywhere due to its universal use in almost every products that are generally used in a day to day life. Since the innovation of plastic, it is estimated that around 8 billion tons of plastic has been produced all over the world in order to cope up with ever growing demand of plastic products . Plastic is mainly a derivative of long chain petrochemical-based materials which is very much indestructible even after a long period of time in the environment. Plastic materials are consisted of a wide range of synthetic or semisynthetic organic compounds with very high molecular mass which are malleable and can be molded into solid objects . Due to the low production cost and easy manufacturing process of plastic materials, it is very much impossible to create an absolute alternative of plastic materials. The main building block of plastic polymers is the Hydro-Carbon monomers. Carbon atoms exist at the main chain of high molecular long chain polymer and Hydrogen atoms are present in the side chain of the polymers. Carbon-Carbon bonds Carbon-Hydrogen bonds are very much strong in nature which makes the polymers resistive of the environmental facts. Plastics have various uses staring from the product packing to the medical uses and so on.



Different types of plastics are produced now a day in order to fulfill different purposes such as, polyethylene are used for the packaging and polyvinyl chloride are used for the making construction materials and pipes due to its higher strength. However the non-biodegradability property of these plastic materials is creating a great environmental threat for all the living being of this planet. Most of the manufactured plastics are getting dumped into the sea which is then consumed by sea creatures and thus entering in our food chain. This uprising problem drives the innovators to find the green alterative of plastic materials where starch based products remains as front liner.Starch is one kind of natural biopolymer which has mainly two polymer types of glucose namely amylose and amylopectin . Starch is mainly a white, soft, tasteless powder like substance which is insoluble in organic and inorganic solvents. The general formula for starch molecule is (C6H10O5) n. Glucose monomers are connected with each other in α 1,4 glycoside bond . Like the plastic materials, starch also has long chain polymers as well. The structure of a plastic (polyethylene) and starch can be seen from the figure 1. Here it can be clearly seen in figure 1(a) that polyethylene has a long chain of polymers consisted with ethylene monomers as the repeating unit. In case of starch, glucose is the repeating unit and they are connected with each other using the α 1,4 glycoside bonds which can be seen in the figure 1(b) as well

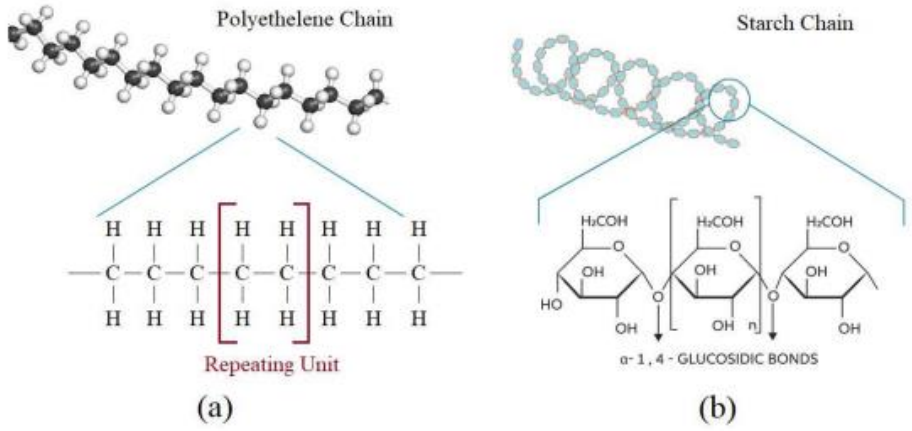


Figure 1: Structure of (a) polyethylene chain (b) Starch chain polymer

The main advantages of starch-based biodegradable plastic are its abundance of raw materials and easy manufacturing process with low cost. During the photosynthesis process, starch is produced in the plants as the reserve food cassava plant, the stem pith of sago, the tuber of the potato and the seeds of corn, rice and wheat. This starch can be collected by crushing or grinding the tubers or seeds and then mixing up with the water in order to collect the starch as the sediment. This organic starch then can be used in order to make the biodegradable plastics by going through various

complicated processes . However, most of the starch based plastics show very poor physical properties such as tensile strength, stiffness and elongation at break and poor moisture stability, which are not suitable for being used as the replacement of plastic products. It is important to enhance the physical and mechanical properties of starch based plastic in order to use them as the alternative of plastics. In this project work the main focus is to develop the manufacturing process of starch based biodegradable plastic with optimal physical and mechanical properties. Improvement of the properties of the starch-based bio-composites is being attempted through starch modification, reinforcements (both organic and inorganic), processing conditions and use of compatibilizers to develop substitutes for the conventional plastics. As the sustainable source of starch which is the main raw material to produce biodegradable plastic, potato is the perfect competitor due to its huge cultivation all over the world. The starch extracting process from the potato is very conventional and easy process. Starch itself can create a film like martial which exhibits very poor mechanical properties. To overcome that hurdle in this project we have added different organic and inorganic chemicals and auxiliaries with starch to enhance the physical and mechanical properties. We have done starch modification by blending starch with polyvinyl alcohol or PVA (polymerizing material) which helps the starch to build much stronger long chain polymer bond. The material Agar-agar is also used to modify the starch and it plays almost similar role as the PVA. In order to prevent the starch from getting affected by fungus or bacteria easy as it is an organic product; acetic acid is also used to prepare the biodegradable plastic. Glycerin is used to control the moisture content in the biodegradable plastic. However, distilled water is used to make the overall solution of starch and other chemical and auxiliaries. The main focus of this project is to find an optimal recipe for manufacturing biodegradable plastic with high-quality properties by working with different combination of the chemicals and auxiliaries. In order to create to different recipes, film formation, polymerization and curing process need to be done. In this research work worked with four different recipes and created four different biodegradable plastics. Among those biodegradable plastics one of them shows very promising physicmechanical properties. Further investigations are done on that particular biodegradable plastic to learn its behaviors. Different physical testes like Tear strength, Tensile strength, Stiffness, GSM, Melting point, Water vapor transmission have been done of the specific biodegradable plastic to understand and inspect the physicmechanical properties. As we are trying to find an alternative of regular plastic through this project, so it is important to make a comparison with regular plastics. We have taken a regular plastic with the same GSM as our biodegradable plastic and we have also completed all the physico-mechanical tests as before which are done to the biodegradable plastic. Test results are then compared with each other to understand how much compatible our new biodegradable plastic

is against the regular plastic. In order to investigate the chemical composition of the biodegradable plastic Fourier-transform infrared spectroscopy (FTIR) test has been done of the produced material . However, most importantly biodegradability test has been done to both the biodegradable plastic and regular non-biodegradable plastic to understand the biodegradable property of the plastic. In order to do the biodegradability test four different bacteria was collected and isolated plastic is to each bacterium. Test results has to be further analyzed and compared with each other to have a better understand of the biodegradable plastic in comparison to the regular plastics.

Chapter-2
Literature Reviews

Rahul Sen , Aditya Maan , Upender Pandel [1]

Most of the pollution in the environment is from petroleum-based plastics as their wastes are toxic and not-degradable, directly affecting plants, animals, and human beings. Bioplastics and biocomposites can play a promising role in such need and are acceptable in many places where petroleum-based plastics are used. They can meet the increasing demands for biodegradable products. One such attempt has been made to synthesize bioplastic and biocomposite from corn starch and glycerol has been added as a natural plasticizer. Cotton threads used for reinforcing bioplastic to give biocomposite. Mechanical properties of the developed bioplastic and biocomposite were investigated. The water absorption capacity was also examined, which directly linked with their bio-degradation characteristic. The SEM images show the surface morphology of the developed bioplastic and biocomposite. There was the significant increase in hardness and tensile strength of developed biocomposite than bioplastic. The produced corn starch has immense potential for future development, can be utilized in places where the items required for short span after use.

D Amalia , D Saleh and E Djonaedi [2]

Bio plastics are polymers prepared from renewable materials. In this study, maize-derived cornstarch and milled corn husk were used as the base material and filler, respectively. Corn husk powder with two-grain sizes of 150 mesh and 200 mesh, respectively, were used. Chitosan was used at concentrations of 0.02 %, 0.04 %, 0.06 %, 0.08 %, and 0.1 % by weight at a constant ratio of 1:1 to cornhusk powder and maize for improving the mechanical properties of bio plastics. The mixture was diluted using a solution containing 2.5 mL of acetic acid (25 %), 1.75 mL of sorbitol, and 70 mL distilled water. Optimum mechanical properties were observed using a cornhusk grain size of 150 meshes with 0.04% of chitosan by weight. This sample exhibited a tensile strength 11.7164 MPa, elongation of 10.05 %, a Young's modulus of 1.1668 MPa,and tear strength of 763.86 mN. A biodegradability of 70– 100 % was achieved in 21 days with the evidence of fungal growth after 14 days. In addition, the sample was able to withstand a temperature of 140 °C for 1 h

Amol Salunke [3]

Now a days, increasing use of petroleum based plastic but it causes a problem in the world environment. So, researchers are finding the alternative material to the petroleum based plastic and that alternative option is biodegradable-plastics. They made up from renewable resources such as cassava, corn, potatoes, sweet potatoes etc. under the certain conditions. That biodegradable plastics are known as green materials because it is friendly to the environment. In addition, most researchers are concerned with renewable resources for nonfood using, suchas biodegradable-plastic production. So that's why, researchers have been focusing on the use of the remains of food and sustainable items as biodegradable-plastic items. In this study, the bio-plastic was produced from cassava starch as the food industry. The study prompts produce biodegradable plastic by utilizing cassava starch and cornstarch as its primary items. In this thesis we review that how starch is going to be used as a main product to producethe bio-plastic. Here we discuss that how we can produce the biodegradableplastic by using different starch or a mixture of starch and also we discuss how plasticizer are used in production of biodegradable-plastic. We also want to develop this type of technology to India.

Van Le . [4]

The aim of this thesis was researching mainly about bio-plastics and bio-plastic production from starch which is a future alternative to petrochemical plastics and to gain more academic knowledge of bioplastics production from different types of starch, to discuss the advantages as well as the limitations existing. The project was approached by related theories, academic explanations and writer's professional opinions including the insight of bio-plastics properties, characteristics, advantages and disadvantages and application of bio-plastics in houseware scale. Particularly science theories prove that it is possible to produce starch-based plastics in different ways in the laboratory and do further research in the future.

Cordeiro, Paula Novais ,Caetano, Skarllet Toledo, DE CARVALHO, Raquel Moreira Maduro [5]

Due to their diverse properties, plastic materials are used in numerous sectors. It is possible to produce different articles and plastic objects with reduced costs, being more accessible to the population. Conventional plastics are obtained from petroleum-derived raw materials, a non-renewable resource in which their extraction and refining process cause major environmental impacts. The production of plastic reaches a level of approximately one hundred and forty million tons per year, and the disposal of these materials is increasing, generating a high rate of waste and leading to an increase of pollution since the decomposition of these materials lasts about five hundred years old. Conventional plastics can be replaced by bioplastics, a material obtained from renewable raw materials such as potatoes, cassava, maize, and which, when disposed of under favorable conditions, decomposes faster, as during its degradation process at least one step occurs. Through the metabolism of organisms present in the environment. Starch has been widely used in the production of biodegradable packaging, so the objective of this work was to produce a biodegradable bioplastic from the potato starch. Potato starch, glycerin, hydrogen peroxide, distilled water, and commercial agar were used to produce the bioplastic. Bench-scale bioplastics had good organoleptic characteristics, similar in appearance to a conventional plastic obtained from petroleum. The thickness, moisture content, and solubility of the bioplastics were analyzed, as well as their fruit preservation capacity. The samples produced were rigid and with good resistance.

Deepti Sharma, Dr. Archana Mankad [6]

Plastics are typically organic polymers often containing other inorganic compounds. Conventional plastics are most commonly derived from precious petrochemicals. But over the time it leads to the depletion of fossils fuels and traditional plastic is proving to be a major environmental problem. In an effort to overcome these issues, an apparent solution being explored was ‘Biodegradable Plastic. In this study biodegradable plastic are produced by using the starch of spoilt potatoes with the help of plasticizer. And this study reveals that Biodegradable plastic made from the starch of spoilt potatoes are good in strength and they are eco-friendly as it is completely degraded within a short period of time. So, Biodegradable plastic from spoilt potatoes gives a promising solution to the environmental problems and it can be used for various purposes in our day to day life.

Rizwana Beevi. K, Sameera Fathima. A.R, Thahira Fathima. A.I, Thameemunisa. N, Noorjahan, C.M, Deepika. T. [7]

Environmental pollution was due to industries, dumping of wastes etc. The plastics are the main threat to environment as they are non-biodegradable. Based upon the above view, there is a need of sustainable material at the same time biodegradable. Such kind of materials are called ―Bio plastics‖. Hence an investigation has been carried out to synthesize bioplastic using banana peels and potato starch and also to study its characterization using FTIR (Fourier Transform Infrared Spectroscopy) analysis, Solubility and Swelling tests. The result of synthesis of bioplastic film from banana peel showed that it was brown and that of potato starch was white in colour. Characterization was carried out by FTIR analysis, The FTIR spectrum was obtained at the wavelength in the range of 400-4000cm-1 . The results of Solubility test of synthesized bioplastic from banana peel and potato starch revealed that it was completely soluble in sulphuric acid, acetone, ethyl alcohol, acetic acid, partially soluble in ammonia and insoluble in water. The results of swelling test for both bioplastics synthesized showed that there was much change when soaked in chloroform and methanol. Slight increase in weight was observed when treated with water medium. Hence the synthesized bioplastic material has the substantial properties like little or zero engorgement and insolubility in water makes it worth for commercial viability and use of renewable resource (banana and potato) will be the best raw material for bioplastics synthesis.

Thu Ya Tun, Aye Aye Mar. [8]

In this research work, potatoes and sweet potatoes were selected as vegetable tubers in the preparation of biodegradable plastic films. Firstly, the starch powders were prepared from potatoes and sweet potatoes by washing, cutting, grinding, drying and pulverizing. The physico-chemical properties of prepared starches such as pH, moisture content, ash content, bulk density, gelatinization temperature and protein were investigated. The elemental compositions of prepared starches were analyzed by Energy Dispersive X-Ray Fluorescence (EDXRF). Secondly, the biodegradable plastic film was prepared using starch powder, water and glycerol as plasticizer. In this experiment, the effects of amount of starch powder, amount of glycerol and volume of water on the tensile strength of prepared biodegradable plastic films were investigated. The organoleptic, chemical and mechanical properties of prepared plastic films were determined and the solubility test was also carried out.

Deepa lakshmi.M ,.Rajeswari Hari. [9]

The increase in population across the globe and the resulting increase in commodities have led to huge demand for variety of materials for various applications. One of the important material that has become an inevitable utility is plastic and its hazard caused to our environment. Bio-plastics help to reduce the dependency on petroleum based polymers and acts as a better servement in controlling the emmission of CO2 in atmosphere. The disadvantages and consequences of handling plastic always lead the scientist in questioning the alternate bio degradable, non-hazardous, eco-friendly material. In view of this, an attempt is made to synthesize plastic through a natural source of ingredient starch . The so produced bio-material will be utilized to replace the toxic plastic and reduce the cumbersome task in decomposition. Bio-plastic is synthesized from potato starch and corn syrup. In order to synthesize bioplastic from vegetable starch, some prelimenary experiments were conducted to determine the adequate proportion of ingredients. The production of plastic requires a polymer (starch), a plasticizer (conc. corn syrup), a solvent (water) and an acid (vinegar) . The yield is a flexible , dense polymer which can be used for several applications in a daily life.

Farhana Momotaz , Naimul Hasan , Aniruddha Sarkar . [10]

Plastic is very much indestructible even after a long period of time in the environment as it is mainly a derivative of strongly bonded long-chain petrochemical-based materials. Nowadays, plastic wastes have become an environmental hazard. However, a Starch based bio plastic can be a solution of this problem. Starch is a natural biopolymer having mainly two types of polymer glucose. In this research work, a biodegradable plastic is developed form potato starch. The advantages of starch-based plastic are its abundance and low cost. However, most of the starch-based materials exhibit very poor physico-mechanical properties like low tensiletear strength, high stiffness, elongation at break and poor moisture stability. Improvement of starch-based bioplastic properties is being attempted through starch modification, reinforcements (both organic and inorganic), processing conditions, and use of compatibilizers to develop substitutes for conventional plastics. The physicmechanical properties of the biodegradable plastic have been ameliorated through some well designed processes. Several tests have been conducted on the biodegradable plastic as well as on the regular plastic in order to make a comparative study between them. Test results showed a very promising start for the biodegradable plastic for becoming the alternative of regular non-biodegradable plastics.

Prachi Sonawane , Amisha Panchal , Shreeya Naik , Bhagyashree Mundaye and Unnati Padalia [11]

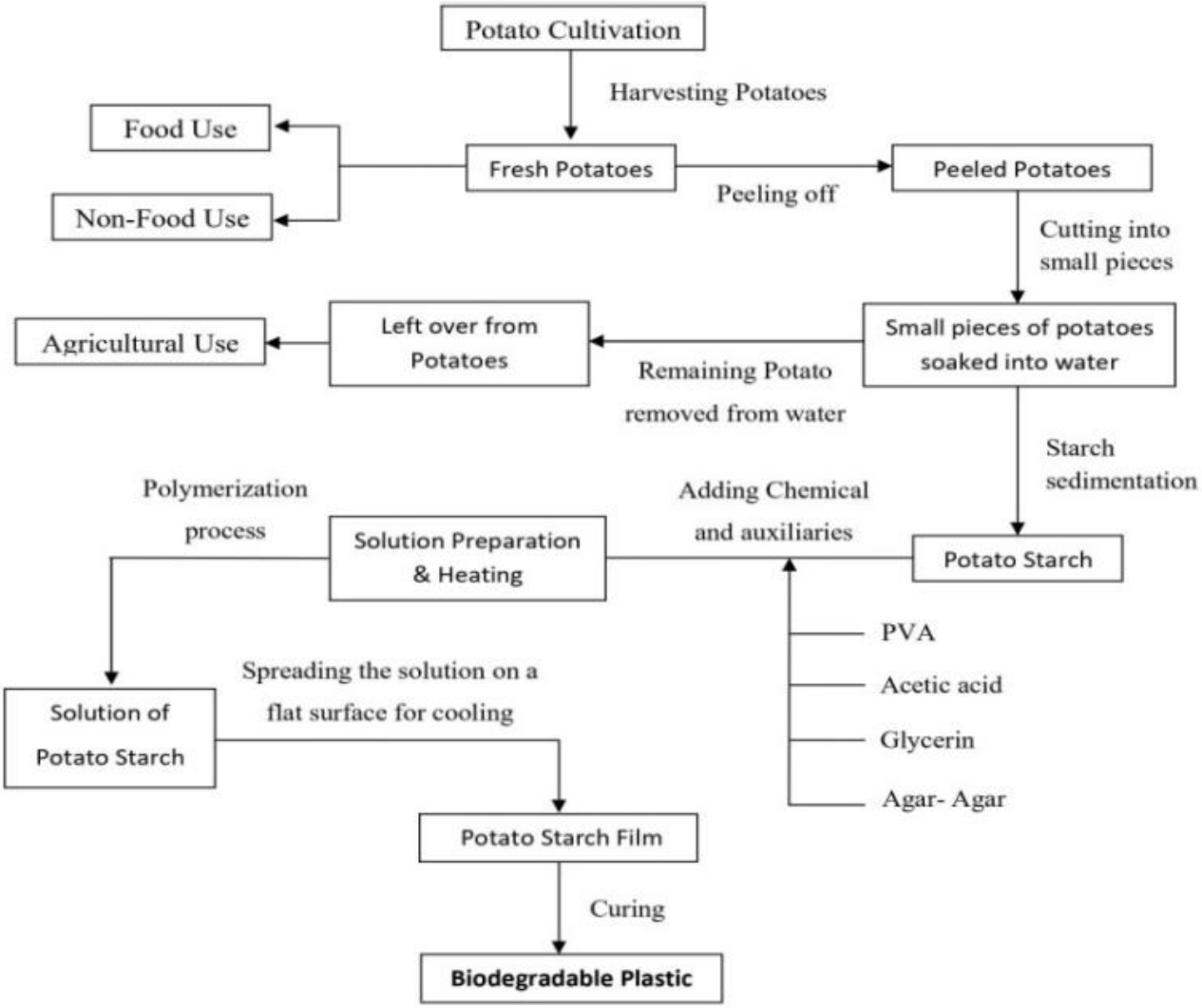
Bioplastics can be synthesized from agrarian outgrowth. Normally, plastics when get accumulated can enhance the biological clock of many organisms which exist in the ecosystem and causes death. It takes around 3-6 months to reprocess. The objective to use bioplastic is to reduce the level of lethality in the environment. It is comparatively less expensive than the normal plastic. Bioplastics prohibit the utility of fossil fuels. Use of plastic materials finds its way in every household and day to day utility. These single use plastic in turn creates abundant waste. Hence it is imperative to produce bioplastics. The materials that were used in the current research project include potatoes, water, hydrochloric acid, glycerol and sodium chloride. Extraction of starch was done by grinding potatoes. The flexibility of the plastic depends on the amount of glycerol added. Acidity of the solution was checked with the help of litmus paper. These bioplastics are known to be biodegradable. It is also eco-friendly. Use of bioplastics may lead to massive reduction in the level of pollution. Hence, substituting bioplastics with normal plastic wherever possible can be a safe option.

Chapter-3
Objective Of The Project

The main objective of using potato starch to create biodegradable plastics is to provide a more sustainable and environmentally-friendly alternative to traditional plastics. These biodegradable plastics are designed to break down more quickly in the environment, reducing the amount of plastic waste that can accumulate in landfills and the natural environment. Additionally, using potato starch as a raw material for biodegradable plastics can also help to reduce the carbon footprint of the manufacturing process by using a locally-sourced, renewable resource. Another objective of using biodegradable plastics made from potato starch is to reduce the dependence on fossil fuel-based plastics, which are a non-renewable resource and have a larger environmental impact. 850 million tonnes of carbon dioxide (CO2) to the atmosphere. A unique feature of bioplastics is that, unlike most conventional plastics, the post-use materials may be treated biologically, e.g. via aerobic composting, to generate carbon and nutrient rich compost as a soil improver. The composting of bioplastics may be carried out with organic wastes either in industrial compost (or municipal) or home compost (or domestic/garden/backyard). Compost can be used as soil enhancer to enhance water retention and increase the availability of water to plants. This has led to the establishing of different standards and certification systems to regulate the composting practices

Chapter-4

Flow Chart



Chapter-5
Materials Used

❖ **Materials to prepare or extraction potato starch :**

- Potatoes
- Normal Water
- Blender
- Silk Cloth
- Tray
- Bowl
- Dryer
- Mixer

❖ **Material required for Synthesis of biodegradable plastics using potato starch**

- Potato starch
- Distilled Water
- Vinegar
- Glycerin
- Medium Blow
- beaker
- Spoons
- Sorbitol
- Agar
- Dryer

Chapter-6
Potato Starch Extraction

❖ **The method used to extract potato starch from potatoes typically involves several steps:**

- Wash the potatoes to remove any dirt and debris with Normal water (required amount potatoes). Fig (1)
- Peel the potatoes to remove the outer layer.
- Grate or shred the potatoes into small pieces.
- Place the shredded potatoes in a bowl of water and let them soak for several minutes. Fig (2)
- By using blender blend all the potato pieces. Fig (3)
- With help of silk cloth drain the blended content by squeeze in the tray. Fig (4)
- After few minutes we can observe potato starch settled at the bottom of tray. Fig (5)
- Now collect the water from tray and pour it off and take starch into blow.
- To get the more efficient potato starch mix water in potato starch and wait for few minutes to starch settle down.
- Repeat for 3 to 4 times.
- Dry the starch using dyer or in direct sunlight . Fig (6)
- Initially the starch formed in solid to get finer particle size use mixer .

Chapter-7
Figures Of Potato Starch Extraction

Fig (1)

Fig (2)

Fig (3)

Fig (4)

Fig (5)

Fig (6)

Chapter-8
Procedure Synthesis Of Biodegradable Plastics

❖ **Procedure synthesis of biodegradable plastics from potatoes typically involves several steps:**

- Take a small bowl with 100ml of distilled water.
- Add the below materials.
    - 20g of potato starch.
    - 12.8g agar.
    - 8ml vinegar.
    - 2ml Sorbitol.
    - 8ml glycerin.
- Now gently mix the sample. Fig(1)
- Taking a Medium beaker and fill with 150ml of distilled water and keep it on the burner respectively place the prepared mixture on the beaker. Fig (2)
- At the medium flame stir the mixture slowly with spoon until Mixture is converted to semi solid.
- Design into the desired shape. Fig (3)
- Use a Dryer or keep it in direct sunlight.

Chapter-9
Figuresof Synthesis Of Biodegradable Plastics

Fig (1)

Fig (2)

Fig (3)

Chapter-10
Test

❖ Tensile strength

Tensile strength test is one of the most common mechanical strength measurement systems while giving axial stretching force on the sample. This test is done to various materials including fabric, plastic, rubber, metals, paper, film etc. In the research work, the tensile test was done by using UTM (Universal Testing Machine). ASTM D638 testing method was used and the standard sample size for testing the tensile strength by using UTM machine was 100 mm in length and 75 mm in width. So 100 x75 mm samples were cut and attached with Page | 7 two tensile grips of the UTM machine. After that the testing process was started and the test speed was 75 mm/min. Whole test was controlled and monitored by using a computer and the test results were also shown in the computer by using a graphical representation. From the graph, different information like, force at pick , elongation at pick, elongation at break, strain at peak and strain at pick etc. can be found and they can indicate the mechanical strength of the tested material.

❖ Tear strength

Tear strength test was done in order to measure how effectively a material can withstand the force after tearing. This test determines how much force is required to rupture a pre-slit material. It is very common for a plastic to get torn by an external force. However, it is important for the plastic to with stand even after being torn. Because if a plastic fails after a small tear and it cannot with stand any longer, then it would not likely to be used for general purposes. So, the tear strength of the biodegradable plastic needs to be much higher in order to use them regularly. In order to do the test, ASTM D1922 testing method was followed and the sample size was 210 mm in length and 50 mm in width. A 15 mm slit was made to each sample according to the testing method. 5 pound dead weigh was used in order to conduct the test using the ELMENDORF Tear Tester M005 model machine. Scaling system of the machine was used according to the amount of dead weight which was used during the test. Amount of tear strength of the samples were directly determined from the position of pointer on the scale.

❖ Stiffness Test

Stiffness generally indicates the hardness and bendability of a material. Stiffness can be determined using both analog stiffness tester and pneumatic stiffness tester. In this experiment stiffness of biodegradable and nonbiodegradable plastic was measured using SUNDOO pneumatic stiffness tester according to ASTM D4032 testing standard. Length of the samples for testing the stiffness was kept at 204 mm and the width was 102mm as per the testing method. Samples were placed on a 4-inch-square steel platform having an orifice of 38mm diameter. A plunger of 25.4 mm diameter pushed the samples through the orifice for a distance of 57mm in 1.7 second. The size of the plunger is smaller than the size of the orifice and it leaves 0.25 inch clearance around all the sides. The value of the force was shown in the screen of the pneumatic stiffness tester machine and the unit Page | 8 of the force was in Newton (N). The maximum force which was needed in order to push the sample through the orifice was recorded as the stiffness value of the testing sample.

❖ Melting Point

Determination Melting point is a very important parameter in case of plastics, because it indicates how much temperature a plastic can withstand before it melts down. There are various methods in order to determine the melting point of a material. Among them, capillary method is a very common one which is actually used in this study in order to manually determine the melting point of biodegradable and non-biodegradable plastic. In this method, a very little amount of testing sample was placed inside of a capillary and the capillary was then placed inside of STUART SMF30 melting point determining machine. The capillary was then heated up and it can be observed by using the eyepiece of the machine. The capillary was then gradually heated up inside of the machine and the sample was observed closely in order to see face transaction of the testing sample. Through the eyepiece, the capillary having the sample and the current temperature which was applied on the capillary could be seen. There was a small screen on the machine which also showed the current temperature of the sample. The temperature of the sample at the exact time when it turned into liquid from the solid state was noted down as the melting temperature or melting point of the sample plastic

❖ Microscopic Examination

Biodegradable plastic is a non-conductive material and due to this reason it is not suitable for Scanning Electron Microscopy (SEM) test. However it is important to observe the microscopic structure of the surface of the biodegradable plastic. So the microscopic structure of the biodegradable plastic was observed by using a XSP L101 Biological microscope. In order to conduct the test, a 15mm2 sample was cut and placed carefully on a glass slide with the help of forceps. The specimen slide then placed and hold in a place on the mechanical stage directly under the objective lens with the help of slide-holder. The incoming light and the focus of the microscope were adjusted so that the specimen could be seen clearly through the eyepiece. There were different magnification levels in the microscope using different lenses. However, in this study 300X magnification was used to observe the surface of the biodegradable plastic. This magnification level was the most suitable for the experiment to observe and have better understanding about the surface of the biodegradable plastic.

❖ Biodegradability Test

In order to conduct the biodegradable test we needed to isolate the bacteria from the soil as per in the previous research [16]. 100gm soil was taken into a water jar and mixed with 1 liter of water. Then the solution was done serial dilution to 10-9M. That solution was used to conduct the biodegradable test of the normal plastic in order to find the intended bacteria which helped for the biodegradable test of our newly developed plastic. Mainly 4 types of bacteria were isolated and their separate colonies were developed in 4 different Petri dishes. They were leveled as bacteria PDB-1, PDB-2, PDB-3and PDB-4. Using the bacteria and supplemented minerals, each samples were placed into a conical flux for 10 days at 37° C inside the JSGI-150T machine. The samples were weighted before and after pulling them in the machine. From the weight difference of the samples, the biodegradability percentage was calculated for each sample by using the equation.

$$Biodegradability\ percentage = \frac{Initial\ weigth - Final\ weigth}{Initial\ weigth} * 100\ \%$$

Chapter-11
Advantages And Disadvantages

❖ Advantages

- They do not cause the death of marine animals such as the tortoise in the sea.
- They do not affect the environment in the form of water pollution or environmental pollution.
- They are light weighed and malleable and can be used for the production of plastic carry bags.
- They reduce the dependency on fossil fuels for the production
- They are made from renewable raw materials such as corn starch and biomass
- The use of potato starch bioplastics has the potential to reduce the environmental impact of plastic production and disposal.
- They are biodegradable, made from renewable resources, have a lower carbon footprint, are versatile, biocompatible, and have consumer appeal.
- As the demand for sustainable materials continues to increase, potato starch bioplastics are likely to become more widely used in a variety of applications.

❖ Disadvantages

- They do not have a long life time since they degrade in the presence of environmental conditions such as microorganisms and moisture
- They show weaker mechanical and chemical properties as compared to degradable plastics.
- Has a considerable cost thus affecting its economic sustainability
- Elasticity should be improved.
- Limited Durability .
- Production Challenges.
- Competing Uses for Raw Materials.
- Limited Recycling Options.

Chapter-12
Conclusion

- Potato starch-based bioplastics have gained attention as a potential alternative to petroleum-based plastics, which are not biodegradable and contribute to environmental pollution.

- The synthesis of biodegradable plastic using potato involves the extraction of starch from potatoes and its conversion into biodegradable plastic.

- However, the process of synthesizing potato-based bioplastics requires further optimization to improve their mechanical and physical properties to make them more suitable for various applications.

- Potato-based bioplastics have several advantages, including being renewable, biodegradable, and non-toxic.

- We got an output of elasticized product which has a similar properties of plastic

- We didn’t conducted some tests as we don’t have proper equipment to conduct the tests.

- The product will have less cost effect on it if we produce more amount of plastic

Chapter-13
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