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Making Biodegradable Plastic to Counter Waste Generation

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Abstract:

For many plastics have been an important part of our lives in terms of their use for many household and other purposes. However, since traditional plastic materials are derived from organic compounds that are responsible for harmful emissions during their manufacture, these plastic bags have been subjected to severe criticism in recent years in terms of their unhealthy impact on the environment. Therefore, the goal of this study was to produce biodegradable plastic without leaving any problems environmental. Therefore, biodegradable plastic bags were created from gelatin and glycerin to reduce environmental problems, so they became known as environmentally friendly. The effect of some influences on biodegradable plastic was studied to identify some of its various properties, such as FTIR spectroscopy, biodegradation, solubility testing in various solvents, and its behavior toward water absorption. The synthetic plastic was observed to be waterproof and chemically inert.

Key Words:
Gelatin, Glycerol, Biodegradable, environmentally friendly.

1. Introduction:

Non-degradable plastic represents one of the important aspects of life, as it is used in many industries, such as the food packaging industry (Cerqueira, M.A.P.R. et al). This type of plastic does not decompose easily, so it causes environmental problems (De Oliveira, L.B. et al). Although this type of plastic is easy to manufacture, it poses problems related to natural ecosystems (Ncube, L.K. et al). Therefore, it is preferable to use environmentally friendly materials of biodegradable plastic. In recent years, it has been used in packaging films as an alternative to non-degradable plastics (Ambrose, D.C.P.) The advantages of biodegradable plastic have emerged, such as its Light in weight and flexible in size as an alternative to harmful plastics in many industrial applications (Hasnan L.). Bioplastic also has the advantage that its manufacturing cost is lower than traditional plastic and it decomposes quickly without affecting the environment (Chander M.). At the beginning of the nineties, plastic materials derived from long-term organic compounds that cause harmful effects on the environment were replaced by short-term biodegradable plastic materials (Mathiot, C. et al). The reason for the introduction of gelatin into the bioplastic industry is its ease of decomposition by microorganisms in the soil without polluting the ecosystem. These properties have made gelatin an essential material in the production of bioplastics used now as packaging materials, and in the future, it will be used in many fields such as pipes and insulating materials

(Chander M.& Arikan, E. et al). In many countries, bioplastics are used in spoons, dishes, and diapers, and it is expected that the number of bioplastics in 2019 will reach 7.8 million (Schulze, C. et al). Therefore, it is believed that the future of bioplastics based on less expensive renewable resources shows great potential in many industries (Kaith, B.S. et al & Anjum, A. et al). Many manufacturers have relied on bioplastic prepared from gelatin and starch to prepare bioplastic because it is available (Roldán-Carrillo, T. et al & Ma, X. et al). Starch is also used in paper making (Naik, S. N. et al).

2. The Theoretical Framework

As a result of the intense need to produce more plastic bags and their harmful impact on the environment. As our waste stores are crowded with these non-degradable materials, these materials produce many harmful chemicals that increase with the decay and appearance of freon compounds. The ozone depletion began to increase. The responsible scientists were able to Environmental diet can overcome this danger, but not to a large extent. Therefore, a large number of environmentally friendly products have been produced, made from natural resources, as an alternative to traditional plastics. An example of this is plastic bags made from gelatin, as this product enables the manufacturer to take care of it, which has health benefits for the environment, which represents an environmentally friendly product. Researchers largely aim to discover more alternatives that are safer for the environment.

3. Methods of Research

Synthesis of Biodegradable Plastic

Based on previous research (2019) (Mrockzcowska, M. et al & Eyre, C. et al) was relied upon in conducting the research that is the subject of the study that will be discussed. In a cup, 12 grams of gelatin were placed in 60 ml of water with constant stirring at a temperature of 60 degrees Celsius, then 3 ml of glycerol was added, and the mixture was stirred continuously at a temperature of 90 degrees Celsius for 5 minutes. Then pour the hot mixture into a polymer container measuring 220 mm x 110 mm, then leave the mixture to dry in the air for 4 days in a well-ventilated place. The resulting bioplastic is then taken out of the container to conduct several tests on it.

Figure 1. Gelatin

Figure 2. Glycerol

Pictures of the stages of biodegradable plastic formation (Images a-g):

Image (a)

Image (b)

Image (c)

Image (d)

Image (e)

Image (f)

Image (g)

a) Infrared Spectra

Infrared spectra are a method for identifying the types of vibrations of the active groups present in a compound. Infrared radiation is directed to the sample, where part of it is absorbed and the other part is passed through the interferometer. A spectrum of radiation intensity is given as a function of wavenumber (cm^{-1}). The infrared spectrum gives light bands that indicate the active groups in the compound. Where effective groups have distinct wavelengths. IR analysis is a powerful tool for characterizing and identifying sample components.

b) Biodegradability Test

The sample is divided into sizes of 2cm x 2cm and then placed in a cup containing an amount of soil around the roots of the plants. The first sample is placed at a depth of 2cm and the second at a depth of 3cm for two weeks. The sample weight is recorded at the beginning and end of the experiment. To calculate the decomposition rate, we use the following law.

Percentage of weight loss

$= ((\text{Weight}_{\text{before}} - \text{Weight}_{\text{after}})/\text{Weight}_{\text{before}})) \times 100$

c) Dissolution experiment

The sample is dried and then cut into seven equal mass lengths. Samples are placed in several different materials for a period of 6 hours, each in a cup. The following materials:

a) HCl, b) H_2SO_4 c) $CHCl_3$; d) CH_3OH, e) CH_3COCH_3, f) C_2H_5OH and g) water. The samples are left in the solutions for 6 hours, then dried in an oven at 50 ^{0}C, and then weighed. The percentage by mass of the solute is estimated by the following law:

Percentage solubility =

$((\text{Weight}_{\text{initial}} - \text{Weight}_{\text{final}}) / \text{Weight}_{\text{initial}}) \times 100$

d) Water uptake experiment

2 samples of different mass are weighed. Each sample is placed separately in a cup containing 60 ml of water at room temperature for a full day. Then we take out the sample, dry it, weigh it, and calculate the percentage of the amount of water absorbed.

Percentage of water absorbed =

$(\text{Weight}_{\text{wet}} - \text{Weight } W_{dry} / \text{Weight}_{\text{wet}}) \times 100$

4. Results and Interpretation

Fourier Transform Infrared Spectroscopy

The goal of using infrared spectroscopy is to determine the bonds resulting from the active groups formed in bioplastics. Chart 3 shows the bonds of gelatin with glycerol mixture of bioplastics produced during the research. The bioplastic spectra obtained for this study showed the existence of six significant absorption peaks.

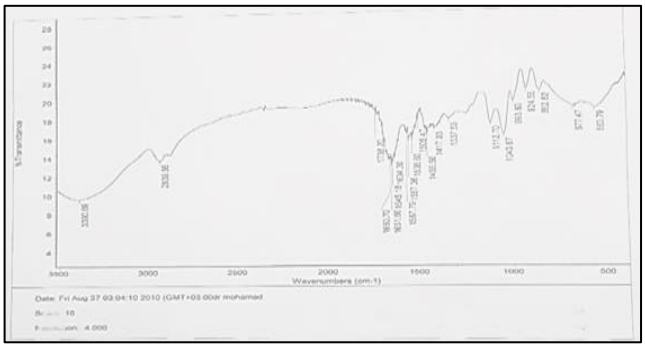

Figure 3. Infrared Spectra

Table 1. FTIR

Functional group	Wave number (cm^{-1})
O–H	3390.69
C–H	2939.56
C=O	1651.66
C=O	1417.03
C–O–H	1043.67
C–O–H	924.55

Biodegradable Test

Two equal samples are weighed and placed at different depths of the soil for two weeks to measure the decomposition rate. We noticed that the bioplastic produced from gelatin with glycerol decreased in mass by 40 % when buried at a distance of 2 cm from the depth of the soil, while the one at a depth of 3 cm decreased by 55 % of its mass.Within a limited period of time, it decomposes and is transmitted to the environment.The bioplastic produced on gelatin with glycerol has shown a high ability to degrade through these experiments

Table 2. Biodegradable test

Sample No.	Sample burial Depth (cm)	Before weight (Wi)	After weight (W)	Weight loss (%)
1	2	0.2	0.12	40
2	3	0.2	0.09	55

Solubility Experiment

Several experiments were conducted on the resulting plastic to determine its effect on different solvents. Experiments have shown that bioplastics are insoluble, which makes them suitable for use in our lives. It also turns out that it does not dissolve in organic solvents such as ethyl and methyl alcohol and acetone. It was also found that it dissolves in chloroform at a rate of 33.3 % and at a rate of 100 % in concentrated sulfuric and hydrochloric acids.

Table 3. Solubility experiment

solvent	weight intial	weight final	Percentage solubility
Conc. HCl	0.12	0	100
Conc.H_2SO_4	0.12	0	100
$CHCl_3$	0.12	0.08	33.3
CH_3OH	0.12	0.12	0
CH_3COCH_3	0.12	0.12	0
C_2H_5OH	0.12	0.12	0
H_2O	0.12	0.12	0

Table4. Experiment of absorption

Sample Number	Weight Dry (gm)	Weight wet (gm)	absorption (%)
1	0.12	0.35	66
2	0.10	0.33	70

Water Absorption Test

To ensure the water absorption of material, a water absorption test is performed. Due to its Due to the water-ability of bioplastics, gelatin, the main component, is responsible for absorbing water. The experiment is carried out by weighing two dry samples and leaving them in water for a full day. It was found that the weight of the first sample increased from 0.12 grams to 0.35 grams, and the second sample increased from 0.10 grams to 0.33 grams. Recent research has shown that gelatin-based bioplastics have the ability to absorb water.

5. Conclusions

A new bioplastic was synthesized, and its composition was confirmed using infrared spectroscopy. It was found that the bioplastic created from gelatin in this project decomposes biologically within approximately 35 days. Therefore, it is preferable to use it for most household purposes. Plastic is now used in most countries of the world. Therefore, several rules must be established for the sustainability of any biodegradable product. In the end, a guide must be developed on how to manufacture and use bioenergy as soon as possible, as it is considered the appropriate alternative to reduce the problem of harmful emissions resulting from traditional plastic materials. Bioplastics are now considered environmentally friendly. Infrared spectroscopy showed that the manufactured plastic films are good and suitable for many purposes. Ultimately, this project also found that this plastic prepared from gelatin is suitable for the environment in terms of preserving it from pollution and because of its other advantages.

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