



**International Journal of Biology, Pharmacy  
and Allied Sciences (IJBPAS)**  
*'A Bridge Between Laboratory and Reader'*

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## CHARACTERIZATION OF POLY LACTIC ACID (PLA) AND SODIUM ALGINATE POLYMERIC FILM

AHUJA S\* , RAJ M AND PAWAR Y

\*Department of Chemistry, Faculty of applied science , Parul institute of applied science,  
Parul university, Limda-391760 Waghodiya Vadodara, Gujarat, India

\*Corresponding Author: Dr. Sonam Ahuja: E Mail: [sonam.ahuja82106@paruluniversity.ac.in](mailto:sonam.ahuja82106@paruluniversity.ac.in)

Received 24<sup>th</sup> Oct. 2023; Revised 25<sup>th</sup> Nov. 2023; Accepted 5<sup>th</sup> April 2024; Available online 1<sup>st</sup> Jan. 2025

<https://doi.org/10.31032/IJBPAS/2025/14.1.8600>

### ABSTRACT

When combining PLA (polylactic acid) and sodium alginate in varying ratios, a range of biodegradable films can be created. These films can serve as environmentally friendly packaging materials in the food industry. Employing analytical techniques such as FTIR , XRD , SEM , and TGA allows for assessing the integrity and composition of the compound, measuring the film's thickness, exploring the material's resistance to temperature changes, and examining the external structure and texture of the film. use of Berries leaves extract with (PLA and Sodium alginate) for antibacterial properties. use of uv spectroscopy for combination of molecules in natural drug extraction. Antibacterial properties of drug loaded film are good for food packaging industries and a good biodegradable polymers.

**Keywords: Polymer, PLA, Film, Biodegradable**

### INTRODUCTION

Commonly shortened as PLA, poly lactic acid is a thermoplastic polymer that's both biodegradable and biobased, coming from renewable resources including sugarcane, maize starch, and other agricultural produce [1]. Its environmentally benign qualities and ability to replace conventional plastics that

originate from petroleum make this a popular and adaptive material in the field of bioplastics. Composed of repeating units of lactic acid, a chemical that can be generated through the fermentation of plant-based carbohydrates, PLA is a linear aliphatic polyester. PLA is a sustainable alternative

for conventional polymer compounds, which primarily originate from fossil fuels, because it is made from renewable resources [2]. When the right circumstances are met, PLA decomposes naturally into substances like water and carbon dioxide if microorganisms occur in the surrounding environment. The thermoplastic polymer poly lactic acid, or PLA for brief, is a biodegradable and biobased product made from renewable resources like sugarcane or maize starch [3]. It is seen as an environmentally beneficial substitute for conventional plastics made from petroleum and is an element of the polyester family. It seems that you may be referring of "polylactic acid" (PLA), a thermoplastic polyester that is biodegradable and produced from renewable resources. On the basis of this supposition, I will give you an introduction to polylactic acid (PLA) [4]. A kind of biodegradable polymer made from lactic acid is known as polylactic acid (PLA). Fermentation of starches from plant life, such as corn, sugarcane, or other crops, is the usual process that yields lactic acid. PLA is seen to be an appropriate replacement for traditional polymers derived from petroleum since it is renewable and biodegradable. Sodium alginate is a sodium salt that is produced from alginic acid, which is a polymer that is naturally present in some kinds of algae and brown seaweed [4]. It is often used as a thickener,

stabiliser, emulsifier, and gelling agent in the food sector. The possible use of sodium alginate to produce gels or textures in a variety of food products is popular. A naturally existing carbohydrates, sodium alginate is produced from algae or brown seaweed. due to its special qualities, it is often used in the food industry and other industries [5]. These are sodium alginate's primary characteristics and applications. A naturally existing carbohydrate, sodium alginate is generated from algae or brown seaweed. It is a sodium salt of alginic acid that finds widespread use in the food sector, medicine, and other areas [5].

## 1. MATERIALS AND METHODOLOGY

### 1.1 Material

Nature Works gave Polylactic acid (PLA 3052 D) to Banka Bio Limited in Hyderabad. Chloroform (Antares Chem Private Ltd.) and sodium alginate (Suvidhith Laboratories, Vadodra).

### 1.2 Methods

#### Preparation of PLA and Sodium Alginate Composite Film:

The solution casting approach was used to create the film. 3.0 g PLA and 7.0 g Na-alg were dissolved in 100 ml clean water on a magnetic stirrer at 50°–60°C and swirled at 480–500 RPM [6]. As a crosslinker, add 1 mL of Glutaraldehyde solution until a homogeneous solution is produced [7]. Finally, the resulting blend solution was put into a basic glass Petri dish and allowed to

dry in air for 48 hours or in an oven for 5 hours at 60° C; composite films were then taken from the Petri plate and saved for additional analysis [8]. The gel and na-alg solutions were developed in weight ratios.

### 1.3 Preparation of berries leaves extract:

The extraction occurred exactly as follows: Freshly collected berry rhizome was cleaned, washed with distilled water, and dried for up to 6 days after being dried again at 50°C in an oven for 5 hours and crushed individually in mortal crushing equipment till a uniform powder was formed after small-scale cutting of dry rhizomes [8]. Next that, 0.5 g samples were placed in a cleaned conical flask, acetone (50 ml) was added, and the resultant mixture was allowed to settle for 4 hours with normal stirring. After the time duration, the extract was filtered with Whatman filter paper (grade 1), and the extracts were stored for further inspection [9].

## 2. Chemical Analysis:

### 2.1 Dynamic Moisture Absorption Studies (KNO<sub>3</sub>):

A study on the moisture adsorption of KNO<sub>3</sub> (potassium nitrate) involving dynamin, likely a typo, could focus on how dynamin, a protein involved in endocytosis, might affect the moisture adsorption properties of KNO<sub>3</sub>. The study would involve experimental techniques to measure how dynamin's presence or activity influences the rate or extent of moisture adsorption by

KNO<sub>3</sub>. This could have implications for various fields, including materials science and biophysics [10].

**2.2 Physiological Fluid:** The water solubility (WS) of the sample has been determined using the Gunter et al. method. Three films (2 2 cm) were baked in a dry oven at room temperature for 24 hours before calculating the initial solids content [9]. The samples were then incorporated in a 50 ml beaker with 30 ml of the PF solution [6]. And then submerge it in the film. The films were set aside for another 24 hours in a dry oven after the first 24 hours to assess the solid content. Examine every 30 minutes to record one reading in Table 2 [11].

## 3. Characterization:

### 3.1 UV/VIS Analysis :

The instantaneous flow electrical resistivity was computed with an auto-range multimeter with an accuracy of 3, and UV-VIS assimilation spectra in the frequency range of 200-900 nm were obtained. UV analysis is usually linked with UV (ultraviolet) spectroscopy, a technique used to study the absorption of ultraviolet light by compounds. It's a typical chemistry method to identify the presence and quantity for particular compounds in a sample [12]. ultraviolet (UV) spectroscopy is especially useful for examining molecules containing double bonds with conjugation, aromatic compounds, and particular functional groups [12].

### 3.2 FT-IR Analysis:

The Fourier change infrared spectroscopy (FTIR) technique can be employed to determine the infrared retention, outflow, and photoconductivity of gases, fluids, and solids. PHB uses the distinction of apart utilitarian groups [13]. The FTIR range was found to be between 4000 and 400  $\text{cm}^{-1}$ . FT-IR assimilation spectra of the examples were obtained using a single pillar Fourier change infrared spectrometer in the spectral range of 4000-400  $\text{cm}^{-1}$  [12]. Since each functional group in a molecule absorbs infrared radiation at various frequencies, FTIR may offer essential details about a sample's chemical structure and composition [13].

### 3.3 TGA ( Thermogravimetric Analysis ):

TGA is an accurate technique to measure the warm stiffness of materials, including polymers. Changes in the heaviness of an example are estimated utilising this method as its temperature is expanded. In an example, TGA may assess humidity and unstable items. TGA works by melting a tiny sample of the material at an ongoing rate in a regulated setting (usually nitrogen or air) [14].

The mass of the sample is constantly monitored as the temperature rises. Evaporation, failure, oxidation, and various other chemical reactions may result in mass changes [15].

### 3.4 Scanning Electron Microscopy (SEM):

SEM is a powerful imaging technique applied in materials science, biology, and numerous other fields for high-resolution imaging and surface morphology study of a wide range of samples [16].

SEM is frequently employed for a range of reasons, including studying material surface properties, defining nanoparticles, examining biological samples, and analysing geological samples. It's a versatile tool for evaluating micro- and nanoscale structures both qualitatively as well as statistically [16].

### 3.5 Xrd (X-Ray Diffraction):

(XRD) is currently an instrument used in materials research to figure out the crystalline structure of an item. The gel/nalg powder was then tested with X-ray diffraction examination [17].

XRD is a highly helpful tool for detecting crystalline phases, calculating the quantities in a sample, and investigating atom arrangement in a crystal lattice. It is frequently used to get insights into the composition and behaviour of materials in materials science, mineralogy, chemistry, and other fields [18].

## 4. RESULT AND DISCUSSION :

### 4.1 Dynamic Moisture Absorption Studies (KNO<sub>3</sub>):

Table 1: Dynamic Moisture Absorption Studies (KNO3)

S. No.	Time	PLA	PLA : SA (20:80)	SA
1	00 min	0.11 gm.	0.22 gm.	0.5 gm.
2	15 min	0.13 gm.	0.21 gm.	0.7 gm.
3	30 min	0.16 gm.	0.23 gm.	0.9 gm.
4	45 min	0.17 gm.	0.26 gm.	0.13 gm.
5	60 min	0.19 gm.	0.29 gm.	0.15 gm.

## 4.2 Physiological Fluid

Table 2: Physiological Fluid studies of PLA/SA films

S. No.	TIME	PLA	PLA:SA (20:80)	PLA: SA (40:60)
0	00 min	0.065 gm.	0.023 gm.	0.021 gm.
1	30 min	0.078 gm.	0.120 gm.	0.110 gm.
2	1 hour	0.080 gm.	0.163 gm.	0.115 gm.
3	1.5 hours	0.087 gm.	0.198 gm.	0.119 gm.
4	2 hours	0.108 gm.	0.219 gm.	0.126 gm.
5	2.5 hours	0.117 gm.	0.225 gm.	0.141 gm.
6	3 hours	0.126 gm.	0.229 gm.	0.170 gm.
7	3.5 hours	0.132 gm.	0.236 gm.	0.204 gm.

## 5. RESULT OF CHARACTERIZATION:

### 5.1 FTIR Analysis

As shown in **Figure 1, 2 and 3**, FTIR analysis can be used to investigate the functional category in a combination. The films treated to gamma radiation showed a positive peak, indicating how the cross-linking technique enhances the chemical interaction between PLA and Sodium alginate. The peak at 1085.16 cm<sup>-1</sup> in the FTIR spectrum of sodium alginate often corresponds with the stretching vibration of the polysaccharide structure's C-O-C (ether) bonds. The C-O stretching vibration is usually attributed to the peak at 1078.55 cm<sup>-1</sup>

in the FTIR spectrum of poly(lactic acid) (PLA), which suggests the presence of ester groups in the polymer chain. Ester functional groups are chemical moieties consisting of a carbonyl group (C=O) which connects to an oxygen atom (O) and another carbon atom. The ester functional group is part of the polymer backbone of poly(lactic acid) (PLA) and applies from the connecting of lactic acid monomers during polymerization. The C-O stretching vibration in the FTIR spectrum about 1078.55 cm<sup>-1</sup> is an ester group-specific signal.

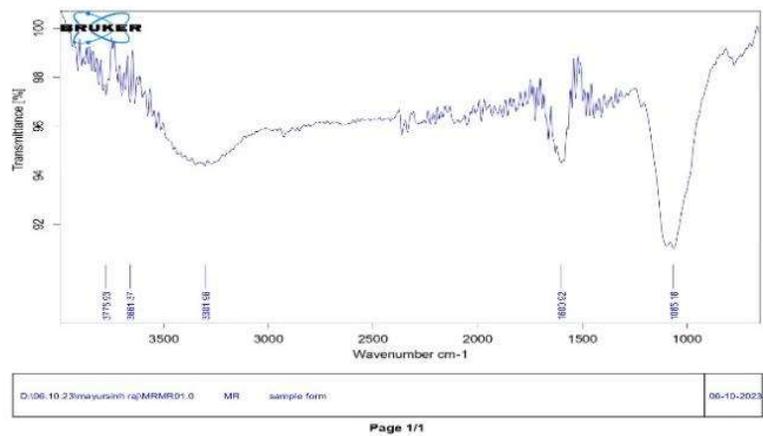


Figure 1: Plain Sodium Alginate

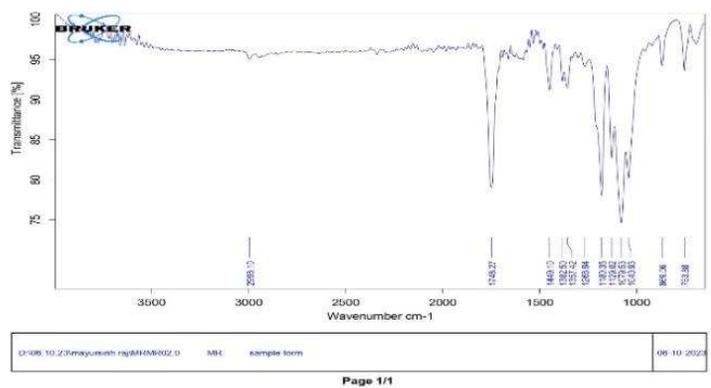


Figure 2: PLA & Sodium Alginate

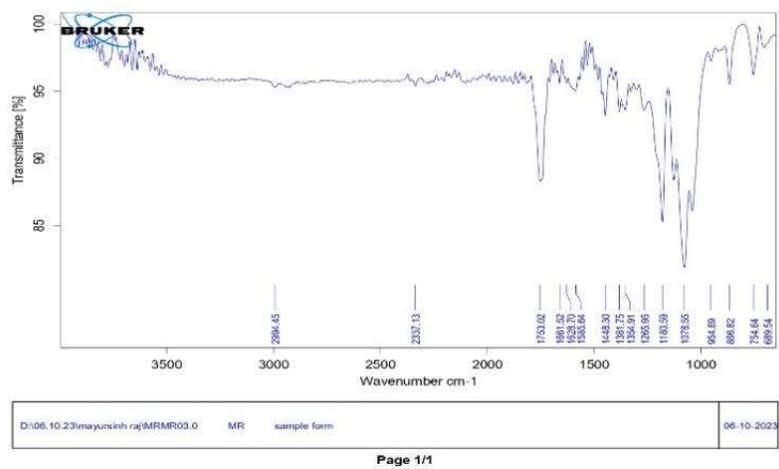


Figure 3: Plain PLA

Figure 1,2 and 3 Showing FTIR spectrum of films sample (1) Plain Sodium Alginate, (2) PLA & Sodium Alginate. (3) PLA

## 5.2 PLA/ Sodium alginate XRD:

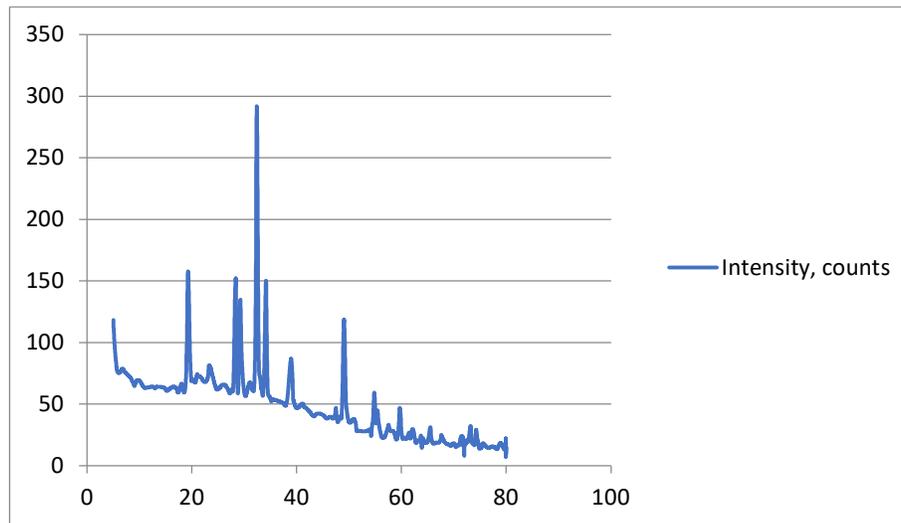


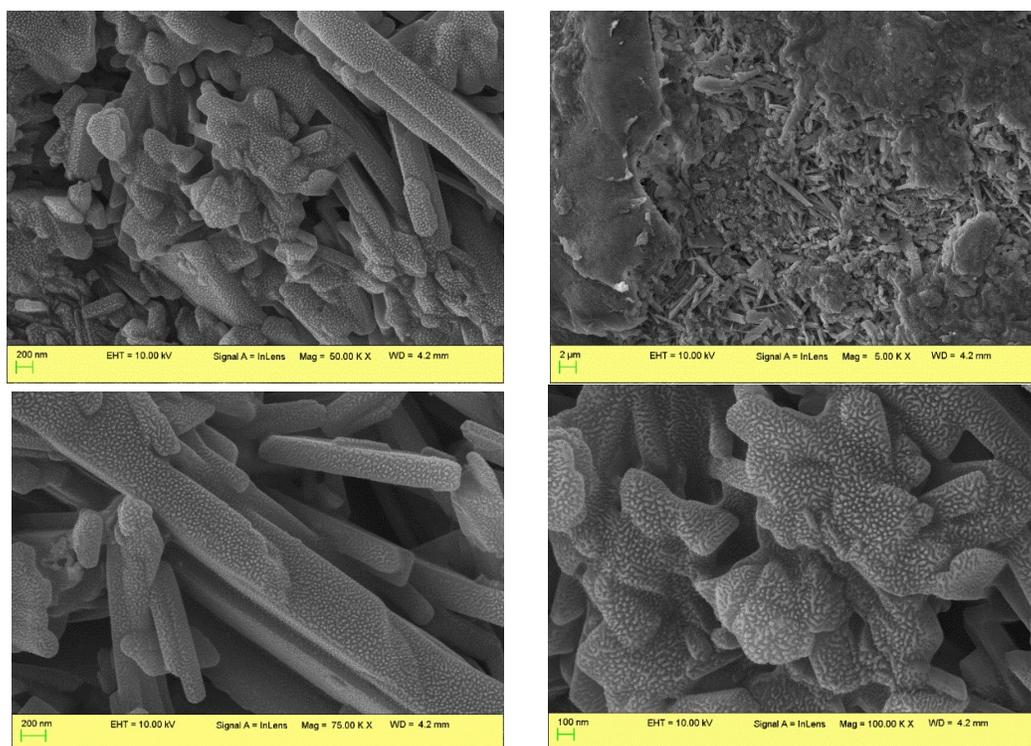
Figure 4: XRD graph of PLA/SA films

XRD research is shown in **Figure 4**; X-ray diffraction reflections were utilised for studying the phase of PLA. Ultimately, PLA produces well-defined signals using decreased peak widths and an amorphous phase. The information gathered confirms findings made by previous researchers.

In **Figure 4**, the intensity value relates to a prominent peak at a diffraction degree of 79.455 degrees. The intensity scale stretches from 0 to 350 arbitrary units (au. ), with 350 au. indicating the highest intensity point. Several peaks demonstrate organised atomic Arrangements within the crystal lattice, and

the overall patten shows the material's crystalline structure. By indicating the amount of X-rays diffracted at each specific angle, the intensity values give details on the abundance of various crystalline planes. The diffraction angles vary from 0 to 100 degrees, that covers the complete range of crystal orientations. The intensity values show the degree of crystallinity, whilst the presence and position of the peaks at specific 30 values show crystal structure. The baseline between peaks shows areas that have less diffraction or amorphous phases.

## 5.3 SEM ANALYSIS



**Figure 5: SEM images of PLA & Sodium Alginate composite film**

Here in **Figure 5**, SEM (Scanning Electron Microscopy) of a polymeric film generated from PLA can reveal critical data regarding the surface characteristics and shape of the film. SEM can reveal the surface topography and texture of the polymeric film. It may display the surface characteristics of the film, such as smoothness, roughness, porosity, or texture, which is important to determine whether or not it meets the requirements for a certain use, such as coatings or packaging. The "EHT" value of 10.00 kV indicates the electron high tension, or voltage applied to the electron source in the SEM. This voltage impacts the energy of the electrons used for imaging, which can

alter the depth and clarity of the pictures developed. Signal A" has been linked with particular configurations with the SEM examination. The magnification level was adjusted to 5.00 KX (kiloX), as indicated by the indication "InLens Mag". The working distance, or the distance at which the electron beam was concentrated for imaging, was kept at 4.0 mm in this instance.

#### **5.4 TGA (Thermogravimetric Analysis):**

Here in the **Figure 6**, TGA study reveals the stability and decomposition characteristic of the PLA and sodium alginate polymeric films. The graph depicts how the weight of the sample changes with increasing temperature, which is crucial for

understanding its thermal properties and potential applications. The temperature treatment for PLA and sodium alginate samples weighing 4.401 mg was carried out at a rate of 10°C/min, with nitrogen gas flow at a rate of 150 mL/min. The TGA test was carried out at temperatures ranging from 30°C to 400°C. The initial temperature was 30.0°C, which climbed at a constant rate of 10°C per minute until the analysis achieved 400.0°C. The TGA graph displays the

weight loss of the heated polymeric film. The sample's beginning weight at 30°C was 4.401 was conducted at a rate of 10°C/min, using nitrogen gas at a flow rate of 150 mL/min. As the temperature reached, the sample began to lose weight. The graph demonstrates the weight loss and mass loss, as well as the rate of decomposition, at various temperatures. At nearly 300°C, the greatest weight loss occurred. The final weight was around 1.000 at 400°C.

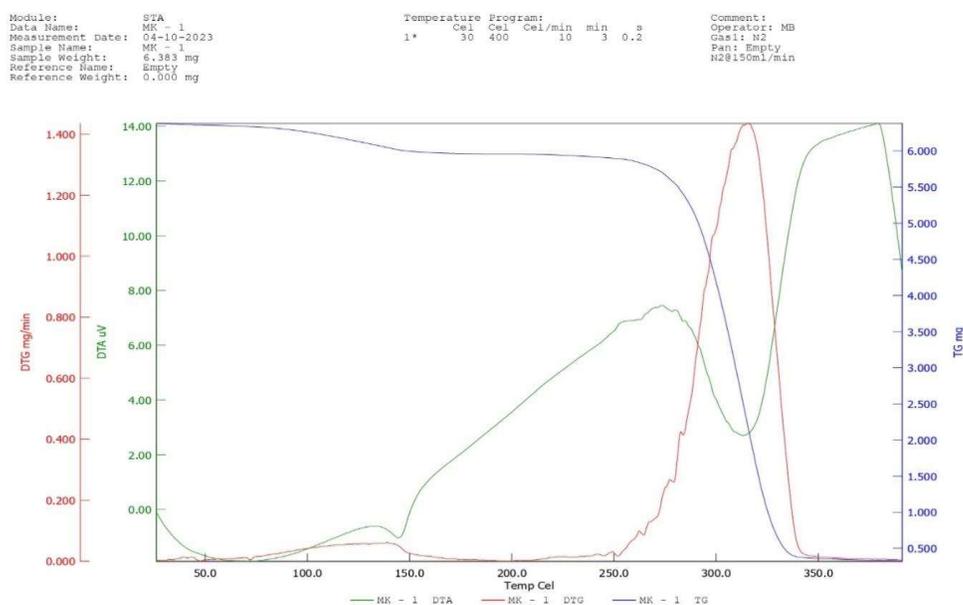
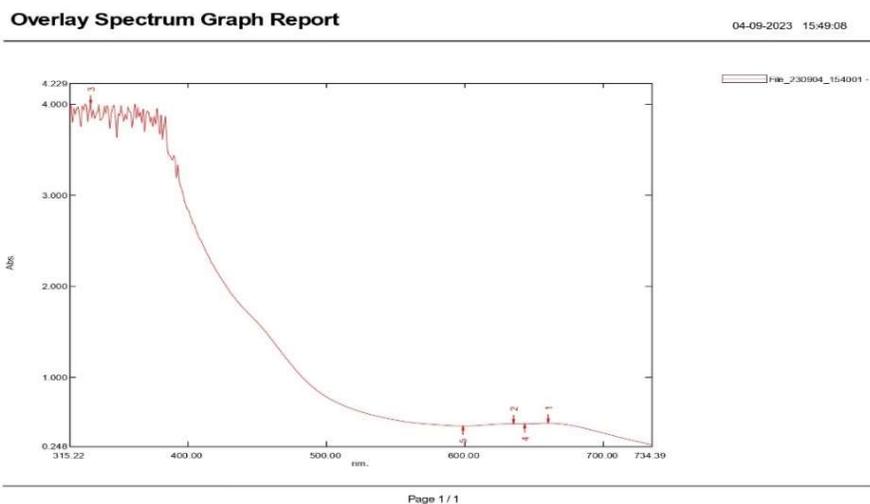


Figure 6: TGA graph of PLA/SA films

The highest temperature at which the composite film can operate may be discovered. It can be stable by looking at the TGA graph **Figure 6**.

### 5.5 UV-Visible Natural Drug berries leaves Extraction



**Figure 7: UV-VIS graph of berries leaves extraction**

Here in the **Figure 7**, the optical density of berries leaves was determined by UV-Visible Spectroscopy. The Absorption peak recorded is at 320 nm wavelength.

## 6. CONCLUSION

PLA and Sodium alginate both are natural polymers and also they both polymers are biodegradable. Composite film of PLA and Sodium alginate are used for food packaging and also used for various purpose of pharmaceutical. Use of natural drug (Berries) for medicinal purpose. It prevent from bacterial properties. Use of natural drug extraction combine with composite film of PLA and Sodium alginate drug loaded film. Antibacterial properties of PLA and Sodium alginate composite film are useful for prevent from wound dressing. The both polymers are biodegradable and useful for food and pharmaceutical industries.

**Conflict of Intrest :** no Conflict of intrest.

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