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PECTIN/CMC COMPOSITE FILM FOR FOOD PACKAGING MATERIAL

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ABSTRACT

The current study examines pectin-based films that have been treated with carboxymethyl cellulose for use in food packaging. The films are made using the solventcasting method, with varying levels of carboxymethyl cellulose and crosslinker (Ca2 ions), and glycerol as a plasticizer. The produced films' FT-IR spectra suggest that whereas OH groups are mostly involved in self-associated hydrogen bonding of neat polymers, carboxyl groups from pectin are primarily involved in interactions with CMC. Additionally, compared to pure pectin films, the addition of carboxymethyl cellulose enhanced the mechanical capabilities, and TGA study revealed satisfactory thermal stability with relation to their prospective use as packaging material.

Keywords: Carboxymethyl cellulose, films, food packaging, pectin, Antibacterial, SEM, TGA, FTIR, XRD

1.INTRODUCTION

Traditionally, food packaging systems have been created as straightforward containers to convey food from the location where it was produced to the retail outlet and ultimately to the consumer. When discussing packaging, additional crucial aspects including delaying deterioration, extending shelf life, and protecting food from external contamination are also mentioned protection against the effects of transportation as well as preservation of food quality. The packaging should shield food from impacts from the environment, such as heat, moisture, and oxygen, enzymes, the loss of odours and offensive odor-causing substances, as well as from micro- and macroorganism attack **[1]**. As is generally known, during the past few decades, synthetic polymer materials have been extensively exploited in all spheres of human endeavour. Petroleum-based polymers make up the majority of raw ingredients in the current packaging industry due to their versatility and favourable performance/cost ratio. Materials made from petrochemical feedstocks pose a global environmental problem and waste because petroleum supplies are finite and they cannot biodegrade or compost generational issue **[2]**. The restriction on the use of typical polymers in the food packaging business developed into a significant problem that's mostly causing the rapid development of cutting-edge biobased systems. The worldwide market is growing more demanding and heavily focused on lowering environmental concerns, as was to be expected.

1.1 **PECTIN:** Pectin is a biodegradable material polymer with a lot of excellent qualities, allowing it an appropriate polymer to be employed in hydrogel formulations. It is a difluoride anionic polysaccharide with several uses, along with the creation of tailored delivery systems **[3]**. substitution of renewable-source packaging materials for those made of petroleum. The use of renewable resources is acknowledged as an elegant and clean solution to issues arising from the disposal of packaging materials on a global scale waste. Various considerations, including cost, availability, mechanical characteristics, transparency, and environmental impact, influence the choice of the best materials for food packaging. brightness, the impact of gas barriers, and immunity to water and microbes The criteria for the material can have an impact on the choice.processing (pH, type of solvent, temperature) the kind and quantity of additives (plasticizers, emulsifiers, or crosslinking agents), and if any, based on the material's packaging's active ingredient content (antimicrobials, antioxidants, texture enhancers, or nutraceuticals) **[4-5]**.

1.2 **CARBOXYMETHYL CELLULOSE (CMC):** where the methyl esterification of the carboxyl groups of uronic acid may be complete (strong hydroxylated pectin, DE > 50%) or partial (low methoxyl pectin, DE 50%) **[6]**. The much more significant cellulose derivative is carboxymethyl cellulose (CMC), which has a backbone made up of glucopyranose residues that are -(1-4) connected. Pectins have an incredibly hydrophilic nature, whereas CMC has amphiphilic properties since it has a hydrophilic polysaccharide backbone **[5]**. Pectin and CMC have been employed successfully as standalone ingredients in a variety of disintegrating film compositions. Due to its great ability to block oxygen, preserve aromas, and block oil, pectin-based films have lately been suggested for use in applications involving food. However, due to its unique structure and high particle size, CMC could be utilized as a filler in films made from polysaccharides **[7]**. According to numerous research, adding CMC to various polysaccharide-based films improved their mechanical and barrier qualities **[8-9]**. The synergistic impact produced by combining these two ingredients in the same dope solution has only been briefly reported **[10-11]**.

1.3 ANTIBACTERIAL DRUG: Infectious diseases cause significant mortality and morbidity globally, particularly in poorer nations due to poor sanitation, unclean environments, and crowded lifestyles. Antibacterials are potent medications that effectively treat harmful bacteria by either eradicating the germs or preventing them from proliferating, which enables the body's own defenses to quickly get rid of them. Resistant strains develop as a result of the targeting organisms' constant transformation into new forms or attempts to evade the effects of medications used to treat bacterial illnesses. Antibiotic abuse, the use of subpar antimicrobials, inexperienced practitioners, and laypeople—particularly in developing nations—have all contributed to the creation and development of antimicrobial resistance. These causes are complex socioeconomic and human behavioral ones.

2. METHOD

Caco3, glycerin, with pectin from citrus (P, DE 70-75% Sigma-Aldrich), carboxymethyl cellulose (CMC), with glycerin (G, Merck, Germany) (Merck, Germany). The eluent was used to create the pectin/CMC films from aquatic pectin liquids (2% w/v). Glycerine was held constant (10 vol.% in relation to pectin), while the cross-linker concentration (Ca2+ ions, 0.005-0.01 mol dm3) and CMC concentration (0, 1, and wt.% in relation to pectin) were adjusted. Cast into circular Teflon molds with an 11 cm diameter, the aqueous treatments of fixed volume (30 mL) including determined amounts of pectin, CMC, and glycerol were dried in the oven at 40 C for 72 hours.

Table 1: Lists the chemical makeup of several film-forming solutions

Samples	% Pectin solutions	% CMC solution	Formaldehyde	Ratio
Pactin/CMC-1	1% Pactin	1% CMC	1ml	50/50
Pactin/CMC-2	1.2% Pactin	0.8% CMC	1ml	60/40

3. CHARACTERIZATION

1. Gelatin Expansion Study: Using the variation in diameter of a round film sample in a 10 % gelatin solution, the growth of the wound management film on the wound surface was examined. In brief, 10 g of gelatin powder were dissolved in 100 ml of heat distilled water by stirring consistently unless a clear solution was obtained. All ratio films having fixed diameters were then immersed in the Resolving the problems in a petri plate, as well as the thickness change was tracked continuously until the sample's width stabilized. The expansion ratio (ER) was determined using the subsequent expression;

2. FTIR analysis: A technique for determining the chemical composition of a composite film consisting of pectin and CMC is known as infrared (Fourier transformation infrared spectroscopy (FTIR). The spectra ranged between 4000 to 400 cm-1 after being dried for 24 hours in an oven with 1% of each polymer. The FTIR analysis was carried out by PNP Analytical Solutions at Vadodara while adhering to all necessary safety precautions **[12]**.

3. XRD analysis: X-ray diffraction is a technique for examining the crystal structure, chemical makeup, and physiochemical functions of a substance (XRD). The XRD study was completed at PNP Analytical Solutions in Vadodara with all necessary safety precautions. the range is 5 to 60 degrees **[13]**.

4. TGA analysis: TGA analysis calculates a research's mass as a result of the time or temperature if regulated heating is available. A technique for material analysis is TGA. The progressive volatilization of the material's component parts over time causes changes in temperature and mass. Due to its ability to measure weight reduction at extremely high temperatures, TGA research is a useful technique for evaluating polymers. While most polymers dissolve at temperatures around 200 °C before deteriorating, some can withstand temperatures of 301 °C on air and 505 °C in inert gases. These polymers can also be researched using TGA **[14]**.

5: SEM analysis: The area of a sample is scanned and images of the material are produced using an electron microscope called scanning electron microscopy (SEM) using a focused beam of electrons. The numerous signals generated by the collisions of electrons the with sample's molecules disclose the top topography and chemistry content of the sample. The top appearance of the Pectin/CMC composite films was examined using SEM to ascertain how they dispersed. The SEM study was carried out by PNP Analytical Solution in Vadodara while following all necessary safety precautions. The electron light's operating width (WD) was retained at 6.6 mm, its acceleration power (HV) was set at 5.00 kV, and an operating width (WD) OF 6.6 mm were preserved **[15]**.

4. RESULT AND DISCUSSION

4.1 Gelatin Expansion: To measure the increase in width of polymer films, expand investigations are carried out **(Table 2)**. To calculate the Expansion ratio (ER), the following equations were used:

It represents the width at period t, and Do represent the initial diameter.

4.2. FTIR: To find pharmaceutical and inorganic contaminants that could contaminate or harm goods, Fourier transformation infrared spectroscopy (FT-IR) is utilized. The earliest step of every sample is therefore usually discovered using FTIR. This allowed for the capture of FTIR spectra for the blend coating with all different ratios, including Pectin/CMC (1:1) and Pectin/CMC (1.2:0.8) **(Figure 1)**. The band frequency results for these two samples with different ratios were as follows:**[12]**

4.3 XRD: X-ray scattering analysis is a technique used during materials research to identify a material's crystal structures. A combination of Pectin/CMC film's XRD spectrum is shown in **Figure 2**. The spectra from an X-ray diffractometer revealed a bump at 33.5(2 = 5.0485), which really is compatible with the film's amorphous state **[13]**.

4.4.SEM: Applying energy dispersive scanning electron microscopy, we looked at how the films were shaped (FESEM). FESEM provides information on the distribution of nanoparticles within the continuous matrix, the uniformity of the nanocomposite, the presence of aggregation, the occurrence of gaps, and the potential direction of nanoparticles. Observations were made on the surface of the Pectin/CMC film after the synthesis **[14]**.

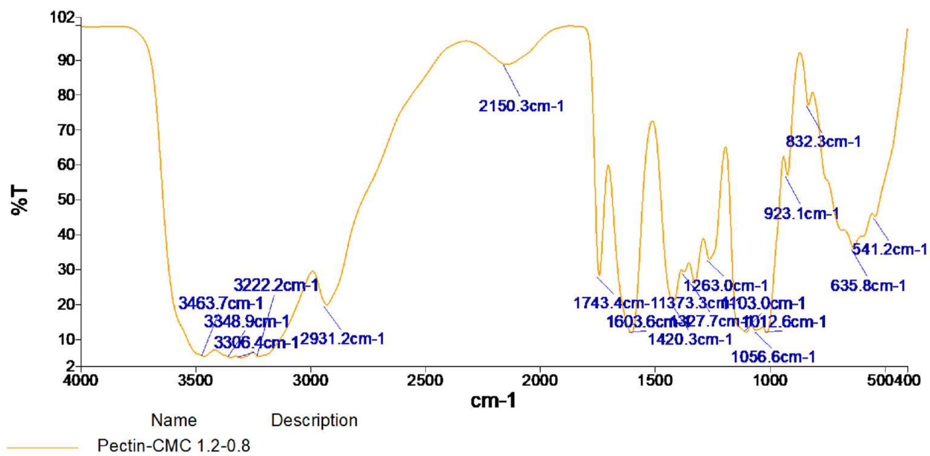
Using area discharge scanning electron microscopy, the geometry of the films was examined (FESEM). FESEM offers data on the existence of gaps, the homogeneity of the composite, the existence of total, the distribution of nanoparticles within the common framework, and the potential direction of nanoparticles. Impressions were created on the PC/CMC film's outer layer after the mixture **(Figure 3)**.

4.5. TGA: The TGA graph and table above demonstrate the stability of the gel at various temperatures, with the results describing taking place at 784.97 °C and the weight retaining only %. The combustion of the above-described gelatin-based compositions was slowed by the inclusion of the second, more stable component, by 27.699%. The quantity of gelatin dispersion used in the blend may be responsible for these outcomes. In order to prevent the less thermally stable element from eroding, the more stable component should serve as a shield **(Figure 4) [15]**.

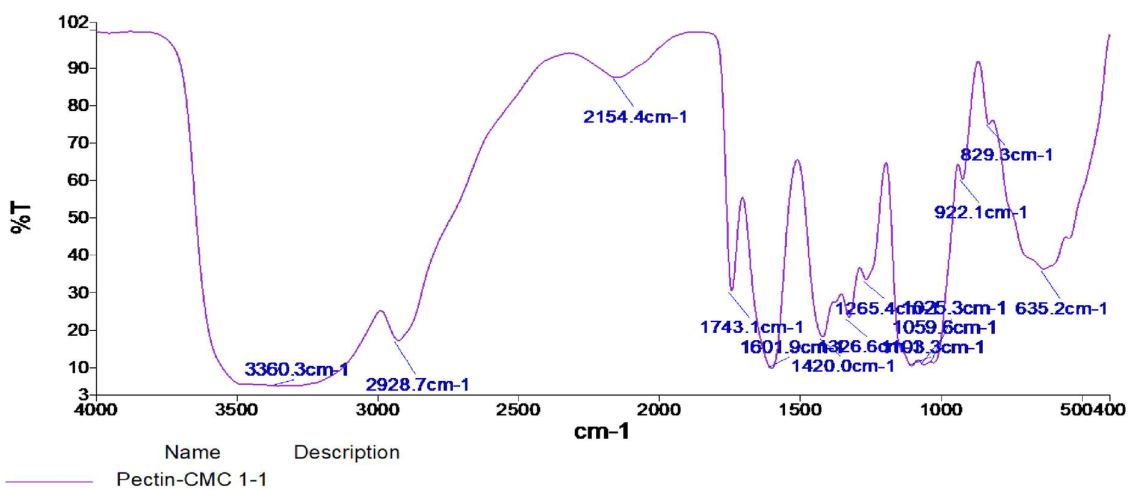
4.6. Antibacterial Activity: The loaded Pectin/CMC composite film's antibacterial efficacy was evaluated using Jimsonweed. Jimsonweed was cooked in a flask with 100 cc of distilled water. The beaker and Plate must be cleaned. The test organism (*E. coli*) should be added to the agar plate solution using a spreader after the media has cooled to room temperature. An agar plate is covered with a portion of the composite film, which is then incubated at 36° C for 24 hours **(Figure 5)**.

Table 2: Gelatin Expansion study table

Time	PC/CMC (1:1)	PC/CMC(1.2:0.8)
0 min	1.2	1.2
15 min	1.6	1.7
30 min	1.12	1.13
45 min	1.15	1.18
60 min	2.21	2.25



(a)



(b)

Figure 1: FTIR spectrum of Pectin/NaAlg composite film with different weight ratios: (a) Pectin/NaAlg = 1:3; (b) Pectin/NaAlg =2:2

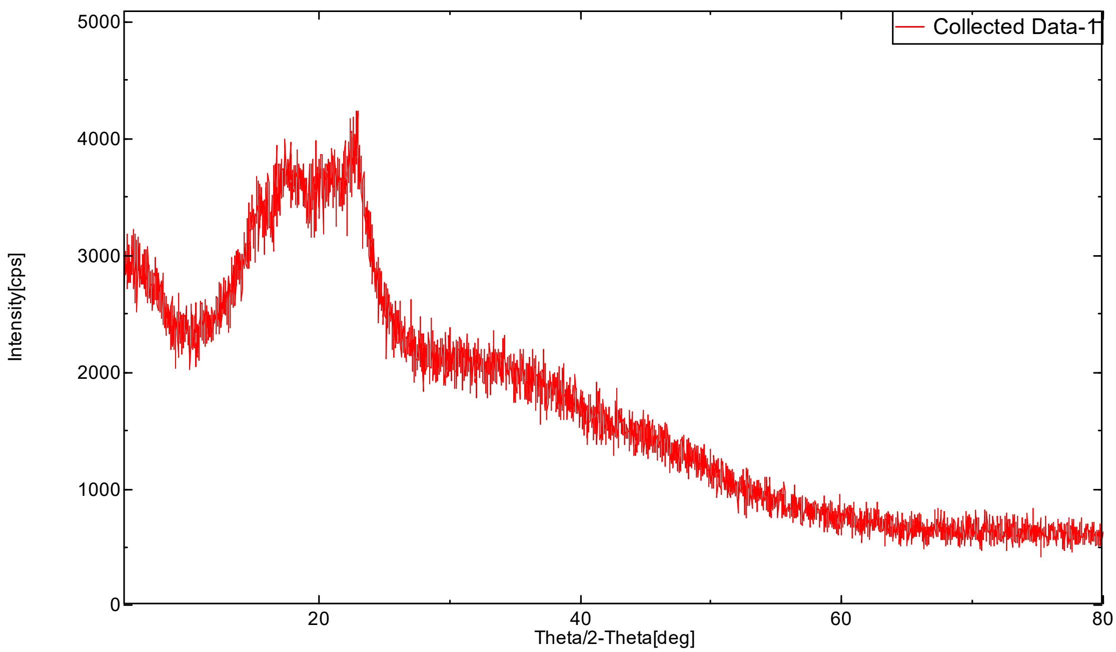


Figure 2: XRD graph

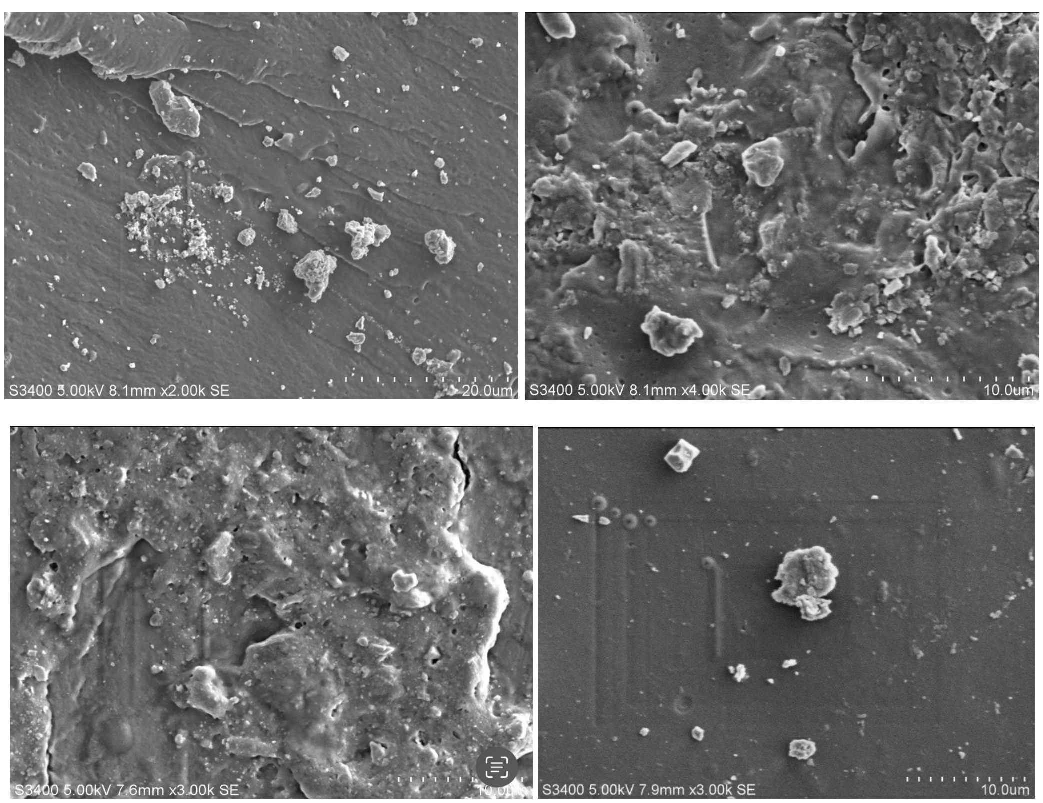


Figure 3: shows FESEM images of the Pectin/CMC film surface

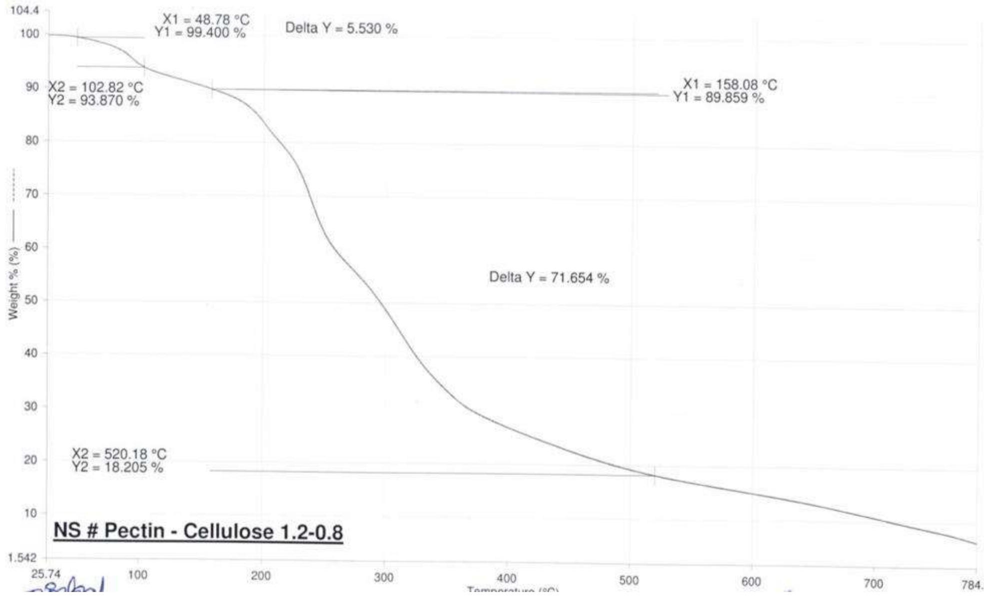


Figure 4: TGA Analysis

Figure 5: Antibacterial Activity

5. CONCLUSION:

Solvent plaster was used to effectively create films made of pectin and carboxymethyl cellulose. In comparison to pure pectin films, it was discovered that adding carboxymethyl cellulose and bridge with Ca2+ions increased the mechanical characteristics. While CMC material had no impact on this measure, the amount of bridge boosted the films' WVP. Even though the researched films have good qualities, more work must be done to make them comparable with the food packaging materials that are currently on the market.

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