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DESIGN AND DEVELOPMENT OF NATURAL STARCH BASED FILM FROM PISUM SATIVUM AND ITS APPLICTION IN FOOD PACKAGING

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ABSTRACT:

Natural Starch from PISUM SATIVUM (Green Pea) based PLA films have been widely used for food packaging application because of its antibacterial activity. Green pea is easily available, low cost with excellent antimicrobial property. Green pea was fabricated using Poly lactic acid (PLA) by solvent casting method. The natural starch-based PLA films were characterized by FTIR and XRD. The surface morphology of the natural food packaging films was analyzed through SEM. This natural food packaging film showed good chemical and physical properties compare to artificial film and has enhanced antibacterial activity with various microorganisms.

Key words: Antimicrobial, Antibacterial, PLA & Microorganisms

INTRODUCTION:

Polymers make up many of the materials in living organisms, including, for example, proteins, cellulose, and nucleic acids. Moreover, they constitute the basis of such minerals as diamond, quartz and feldspar and such manmade materials as concrete, glass, paper, plastics and rubbers. Most natural and synthetic polymer, however, are made up of two or more different types of monomers; such polymers are known as copolymers. Flexible packaging mainly uses biodegradable polymers and rigid packaging mainly contributes to non-biodegradable packaging. Biodegradable polymers are also used for modified atmospheric storage for different fruits and vegetables **(1).** Food packaging can prevent food damage. It is essential to select the proper materials and packaging techniques to retain food quality and freshness. Edible film packaging is new and environmentally friendly food preservation technique compared to conventional packaging. The biodegradable film retains food quality and is environmentally friendly. **(2).** Degradation at high temperature, such as in pyrolysis (burning) tends to cause emission of toxic fumes. Plastic accumulation in the environment thus creates tremendous problems for the world, presently and in the future. Environmental problems caused by plastics include changes to the carbon dioxide cycle, problems in composting, and increased toxic emissions. Stimulated by environmental concerns, scientists are now concentrating on ways to develop plastics that will be used more efficiently. Two simple strategies are to “recycle” or to produce plasticsthat will degrade when no longer required.

There has been a widespread interest in films made from renewable and natural polymers which can degrade naturally and more rapidly than the petroleum-based plastics. Among all biopolymers, starch is being investigated as a potential material for biodegradable films **(3).** Starch consists of two types of polysaccharides, namely amylose and amylopectin. Amylose is a linear molecule with a few branches, whereas amylopectin is a highly branched molecule. The most commonly used plasticizers in starch films are polyols, such as sorbitol and glycerol **(4)**. The main interest in 'biodegradable' plastics is that they break down into simpler components sooner than traditional plastics. In addition to renewable raw ingredients, biodegradable materials break down to produce environmentally friendly products such as carbon dioxide, water, and quality compost **(5)**. Biodegradable polymers made from cellulose and starches have been in existence for decades, with the 1st exhibition of acellulose-based polymer **(6).**

PLA is an aliphatic and thermoplastic poly-ester that has attracted considerable attention because of its biocompatibility, compostable characteristics and no toxicity to the human body and environment. This polyester has attracted attention because it is readily available and cheap. Lactic acid is usually synthesized from either bacterial fermentation or from synthesis of petrochemicals. The PLA with low molecular weight is manufactured by the direct polycondensation of lacticacid.

A process for forming thermoplastic polymer samples by dipping a mould into a solution of the polymer and drawing off the solvent to leave a polymer film adhering to the mould. Casting is the process in which liquid polymeric material is poured into mould. This method is called as "solvent casting" because the polymer is completely soluble in the solvent which ensures uniform distribution hence fulfilling one of the ideal scaffold properties**.**

2. EXPERIMENTAL

2.1 MATERIALS

All chemicals were in analytical grade and were used as received without any additional purification. Poly Lactic Acid (PLA), Chloroform and Natural starch of Pisum Sativum.

2.2 SYNTHESIS

The natural starch of the Pisum Sativum (green pea) was prepared by solvent casting as allows: 2.0 g of pure PLA was mixed in 50ml chloroform solvent and the mixture was dissolved continuously until a clear solution was obtained. The derived product of PLA is then mixed with 1.0 g of green pea powder then this solvent was stirred for 1:30h to obtain a homogeneous solution. The resultant product is poured into Petri dish to form thin film, further dried in ambient conditions, and this solvent is slowly evaporated for 5 days, after 5days the film was peeled out. The film was powdered and gave for further studies.

3. RESULT AND DISCUSSION

3.1 Structural Analysis (XRD)

X-Ray diffractograms PLA and PLA composites were studied to better understand their crystalline properties. The PLA loading plot (Fig.1) showed a very marked discrimination according to the peaks at 2θ = 16.50◦ (200), 19.04◦ (203) and 22.22◦ (213) corresponding to a typical X-ray pattern of starch. For X-ray, the relative crystalline is obtained by separating the crystalline peaks. A smoothed line that separates the amorphous and crystalline starch of an XRD pattern is obtained by applying a moving average to the original pattern **(7).**

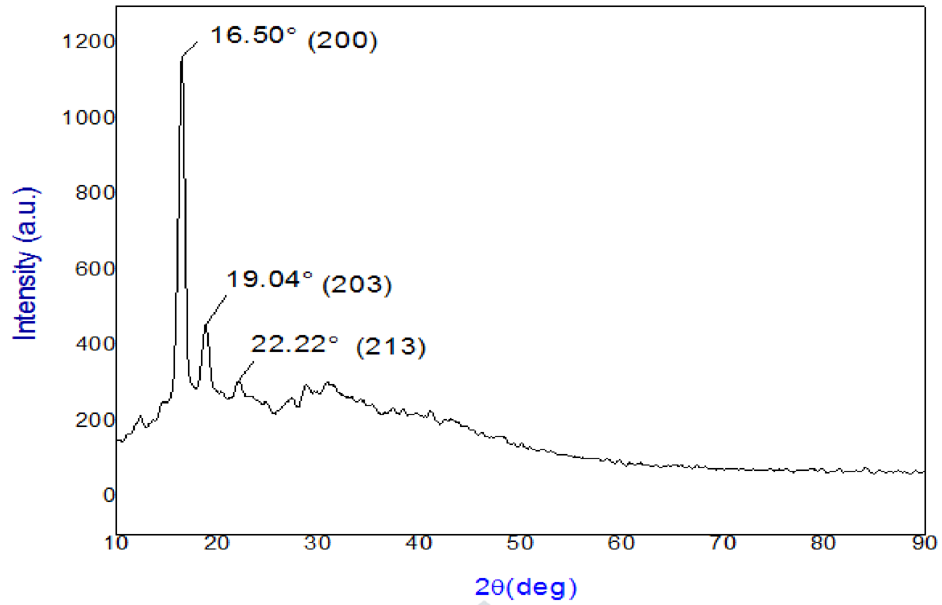

Fig.1: XRD Spectrum of Natural Starch-based PLA film

3.2 Spectral Analysis (FT-IR)

The grafting of poly lactic acid onto starch granules was confirmed by FTIR spectrum. Fig.2 displays infrared (IR) spectra of the starch, PLA and starch with poly lactic acid. The IR spectrum of the starch includes a broad band between 3700 and 3000 cm^{-1} which correspondsto the stretching of the hydroxyl group (–OH) and also a peak at 1639 cm^{-1} caused by the bending of the same group. In addition, the spectrum exhibits two signals at 2934 cm^{-1} and 2892 cm^{-1}, which correspond to the asymmetric and symmetric stretching of methylene group (–CH2), respectively. The PLA spectrum has an intense peak at 1754 cm^{-1}, which corresponds to the stretching of the carbonyl group (C=O) of the polyester; moreover, characteristic stretching signals from the –CH group can be observed at 2992 cm^{-1} and 2877 cm^{-1}. The spectra for the grafted starch show the starch signals and the appearance ofthe signal due to the carbonyl group of poly lactic acid (PLA), which confirms the grafting of polymer on the starch chains. Additionally, the signal intensifies with increasing addition of PLA. **(8).**

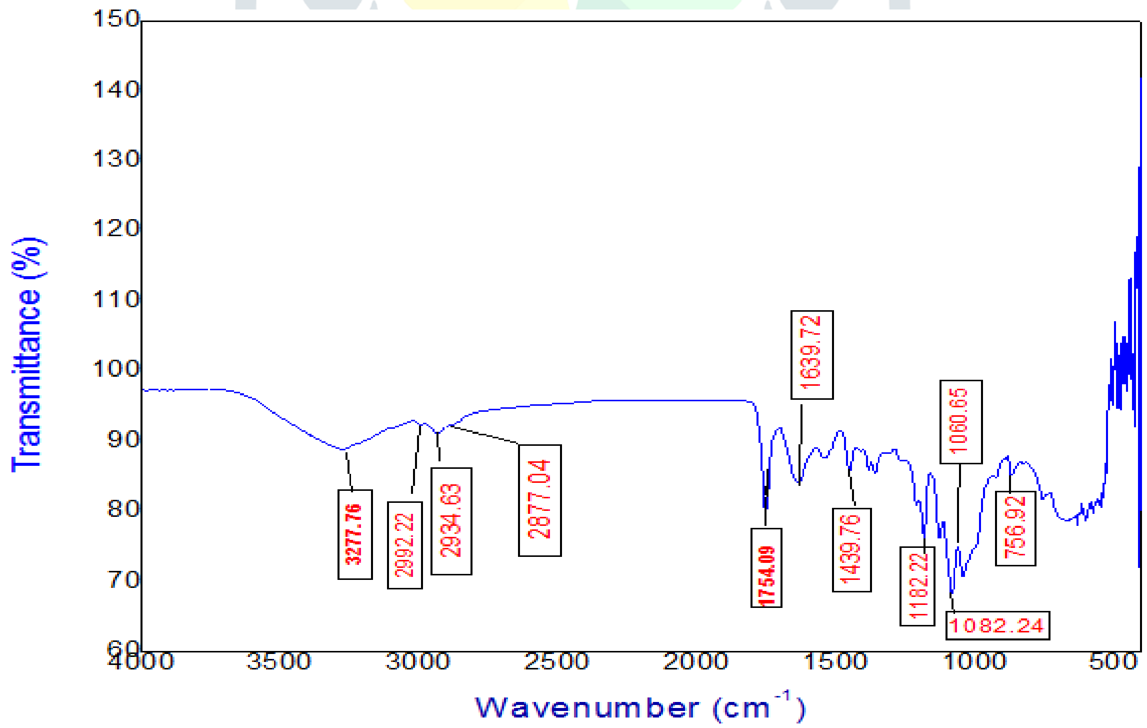

Fig.2 : FTIR Spectrum of Natural Starch-based PLA film

3.3 Scanning Electron Microscopy (SEM)

SEM is mostly used to analyze the size, shape, and morphology of substance the Fig.3 shows the SEM of starch-based PLA film. It shows stratified structure that slowly disappeared into small voids at the cracked surface of PLA. Increasing the magnification exhibited with aggregation **(9).**

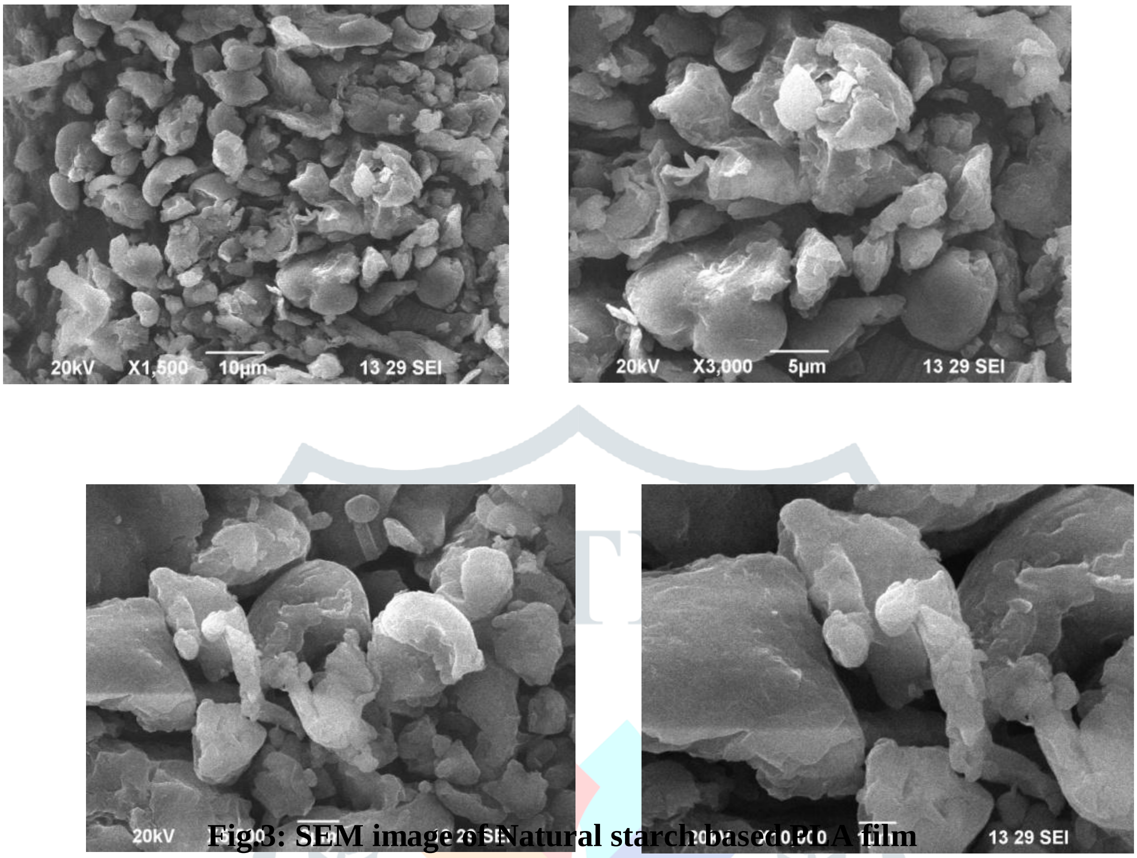

Fig.3: SEM image of Natural starch based PLA film

Fig. 3 SEM images of starch-based PLA film

3.4 Antimicrobial activity

The antimicrobial activity of synthesized natural starch based PLA films was tested against two bacterial strains, E-coli, Staphylococcus aureus. It used to development of numerous food spoilage and toxious microorganisms. A packaging material among antimicrobial would be agent an essential and enviable for universal use to progress the storage. The inhibitory activity was considered on the average diameter of the obvious inhabitation zone. If there was no clear zone close to the extract loaded disks, it was implicated that there was no inhibitory effect. The E.Coli bacteria showed excellent antibacterial activity compared to Staphylococcus aureus. So this food packaging has good antibacterial effect.

Inhibition zone of different solvent extracts of PLA against *Staphylococcus aureus* and *E. coli*

Pathogens	Zone of inhibition (in diameter)					
	Ethanol	Acetone	Chloroform	Methanol	Aqueous	Positive control
Staphylocousaureus	15±0.81	2±1.27	25±0.47	5±0.63	15±1.59	34±0.50
E. coli	18±0.76	21±0.92	9±0.22	--	26±0.11	31±0.33

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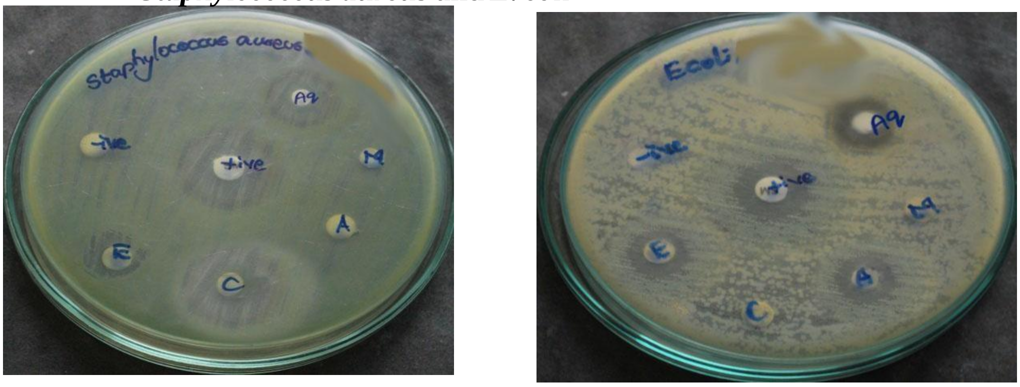

Fig.4: Anti microbial activity of Natural Starch based PLA film

4. Conclusion

Antimicrobial biodegradable polymeric films can substitute the conventional packaging material to reduce environmental hazards and extend the shelf life of food products. The natural starch based PLA films were generated using chloroform as a solvent. XRD result of PLA composites was studied to better understand their crystalline properties. The grating of poly lactic acid onto starch granules was confirmed by FTIR spectrum, which confirms the grating of polymer on the starch chains. The SEM image of starch based PLA films shows stratified structure that slowly disappeared into small voids at the cracked surface of PLA. According to antimicrobial activity results, starch can be used as antimicrobial agent against the microorganism. It can be observed that the incorporation of starch-based films is very effective against E.coli and staphylococcus. So this food packaging has good antibacterial effect. Due to their environmentally friendly and anti-microbial properties, starch-based films have the potential to be used in food in food packaging product applications. The development of such fully biodegradable packaging films will help to tackle the current environmental problems caused by the disposal of non-biodegradable plastics.

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