PREPARATION AND CHARACTERIZATION STUDY OF CHITOSAN-BANANA FIBER POLYMER COMPOSITE FOR PACKAGING AND TISSUE DESIGNING

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Abstract: *Polymer network composites are thermoplastic or thermosetting polymers strengthened with natural or inorganic fillers. In the progressing years, basic strands are used as bracing administrators to make standard fiber reinforced polymer composites rather than designed fibers which are from oil sources. An extensive part of the composites of hydrophilic regular strands with hydrophobic designed polymers encounter the evil impacts of the nonattendance of strong interfacial bond between them. To conquer this trouble, the present examination expected to mix a characteristic fiber with biopolymer to create an all-green Biocomposite film. For this reason, chitosan a cheap, biodegradable and biocompatible biopolymer was been mixed banana filaments. The crude filaments were pre-treated by mercerization (5% of NaOH arrangement) The after effects of pre-medications demonstrated that the expulsion of lignin and hemicelluloses materials from the strands affected decline in hydrophilicity, Increase in surface smoothness, in this way rendering the filaments appropriate to be Blended with chitosan. Crude and pre-treated strands were blended with chitosan and cast in to films. The impacts of pre-treatment of fibers, rate structures of the mixes film were assessed by utilizing tensile test, XRD, SEM, water ingestion and biodegradable test. In light of the above outcomes chitosan banana films arranged in the present examination can be proposed as materials reasonable to be produced for packaging industry and tissue designing applications.*

Key words: *Chitosan, Banana Fiber, XRD, SEM, Biodegradation, Water absorption*

1. INTRODUCTION

1.1 Chitosan

In the present study, one of the inexpensive, promising biopolymer, Chitosan, is used as a film forming material. Chitosan finds diverse applications in various fields such as medicine, agriculture, food and water treatment. However, the wider applications of chitosan powder, film, gels and membranes were limited due to its brittleness and hydrophilicity. To improve the strength and hydrophilicity, other materials are mixed with chitosan. The simple blending can be done in many ways such as, casting, injection moulding, compression moulding, and electrospinning. Chitosan can be blended with many synthetic and natural polymers to form composite materials. Because of its biodegradability to non-toxic end products in vivo, it has been widely used in biomedical applications. Because of its film forming property, it can be used in wound dressing, drug delivery applications and tissue engineering scaffolds. Chitosan is used in food packaging industries as clarifying agent. It is used as antimicrobial film to cover fresh vegetables and fruits.

Chitosan is created monetarily by deacetylation of chitin, which is the auxiliary component in the exoskeleton of shellfish, (for example, crabs and shrimp) and cell dividers of parasites. The level of deacetylation (%DD) can be dictated by NMR spectroscopy, and the %DD in business chitosans ranges from 60 to 100%. All things considered, the sub-atomic weight of economically delivered chitosan is in the vicinity of 3800 and 20,000 Daltons. A typical technique for the union of chitosan is the deacetylation of chitin utilizing sodium hydroxide in overabundance as a reagent and water as a dissolvable. The response happens in two phases under first-arrange dynamic control. Initiation vitality for the initial step is higher than the second; its esteem is an expected 48.76 kJ/mol at 25-120°C. This response pathway, when permitted to go to consummation (finish deacetylation) yields up to 98% item.

1.2 Banana Fiber

Banana fiber is extricated, not on a business advantageous scale anyplace in the nation. For extraction of strands from the pseudostem, the most widely recognized strategy followed in Indian towns is hand rejecting, i.e. to scrap the stem with limit metal edge. The downside of hand rejecting is that the fiber output is low. The basically hand driven procedure of extricating banana fiber is presently set to change with the development of the Banana Fiber Separator Machine. A less demanding also, speedier method for separating filaments is to utilize a machine extractor, called Raspador, Banana Fiber is extricated from Banana pseudostem sheaths. A few endeavors to extricate the fiber by customary strategies like Hand extraction are being made in territory of Kerala yet the amount of fiber created is very little. In some banana developing nations of the world like Philippines, Uganda, China, and Indonesia methodical extraction of banana fiber is being completed. The plants are chopped down when the natural products are reaped. The storage compartment is peeled. Dark colored green skin is discarded holding the cleaner or white portion which will be handled into tied strands. To separate the fiber, the pseudostem is cut at the base at an edge, and its sheaths are expelled, as every arrangement of leaf sheaths produces distinctive evaluations of strands. It would be attractive to isolate them as indicated by the arrangement said above preceding the cleaning or stripping that would empower the craftsmans to showcase the filaments profitably. The strands are extricated through hand extraction machine made out of either serrated or non serrated blades. The peel is braced between the wood board and blade and hand-pulled through, evacuating the non-sinewy material. The removed strands are sun-dried which brightens the fiber. Once dried, the filaments are prepared for hitching. A pack of strands are mounted or braced on a stick to encourage isolation. Every fiber is isolated agreeing to fiber sizes and assembled appropriately. To tie the fiber, every fiber is isolated and hitched to the finish of another fiber physically. The partition what's more, tying is rehashed until the point that groups of unknotted strands are done to frame a long consistent strand. This fiber would now be able to be utilized for making different items. One additionally fascinating truth related with the improvement of this machine is that it utilizes the farming misuse of banana harvests to deliver silk review fiber. These silk review filaments are of tremendous help to the crafted works what's more, material industry. What was already viewed as a horticultural waste is presently changed over to a crude material for good quality silk like yarn.

2. METHODOLOGY

The objective is to investigate the behavior of material specimens under a Tensile Test, XRD, SEM, water absorption and biodegradable test. The materials to be investigated on chitosan-banana blended film. From performing the Tensile Test the following properties will be determined; young's modulus, yield stress, ultimate tensile stress, percentage elongation at fracture, percentage reduction in cross-sectional area at fracture and fracture stress. This experiment is used to determine a material's properties, and is used in a wide range of industries. One example of this could be to determine the Ultimate Tensile Stress of a material to be used for packaging in industry and skin implant, to check it can hold enough tension.

3. PREPARATION OF CHITOSAN-BANANA BLENDED FILM

3.1 Mercerization of Raw Banana Fibers

- Weigh the 5 g of chopped banana raw fiber
- Weigh out the 10 gram of NaOH flakes in a beaker.
- Prepare a 5% NaOH solution in beaker (10 gm sodium flakes).
- Treat banana fiber with 5% NaOH (200ml) at room temperature for about 2 hours with vigorous stirring.
- The reaction mixture turned to dark brown colour.
- Mercerized fibers were filtered and thoroughly washed with water and then dried.

3.2 Preparation of Banana Fiber and Acetic Acid Solution

- Take a 200 ml of water and add 4 ml of acetic acid glycial (2% acetic acid) stir the solution for 15 min
- Weigh 1 gram of banana fiber
- Chop 1 gm of mercerized banana fiber.
- Add 1 gm of chopped banana fiber into 2 % acetic acid (200 ml) and keep it for 5 days.

3.3 Preparation of Chitosan Solution

- Weigh 2 gm of chitosan powder.
- Prepare 2% acetic acid solution separately (100 ml) and
- Slowly add 2 gram of chitosan powder to acetic acid solution and stir it until it dissolve completely.

3.4 Preparation of Chitosan - banana Blended Film

- Mix 200 ml acetic acid (which contains fibers) and 100ml acidic acid (which contains chitosan powder), keep it for stirring for few hours
- Filter using strainer, pour into petri dish plate and keep it for vaporization**.**

4. EXPERIMENTATION

4.1 Tensile

Tensile test are performed for a few reasons. The consequences of tensile tests are utilized as a part of choosing materials for engineering applications. Tensile properties much of the time are incorporated into material details to guarantee quality. Tensile properties regularly are estimated amid advancement of new materials and procedures, with the goal that extraordinary materials and procedures can be analyzed. At last, tensile properties frequently are utilized to foresee the conduct of a material under types of stacking other than uniaxial pressure.

4.2 SEM

A normal SEM works at a high vacuum. The fundamental rule is that a light emission is created by an appropriate source, regularly a tungsten fiber or a field discharge weapon. The electron bar is quickened through a high voltage (e.g.: 20 kV) and go through an arrangement of gaps and electromagnetic focal points to deliver a thin light emission., at that point the pillar examines the surface of the example by methods for check curls (like the spot in a cathode-beam tube "old-style" TV). Electrons are radiated from the example by the activity of the examining shaft and gathered by an appropriately situated identifier.

The magnifying instrument administrator is watching the picture on a screen. Envision a spot on the screen examining over the screen from left to right. Toward the finish of the screen, it drops down a line and sweeps crosswise over once more, the procedure being rehashed down to the base of the screen.

The way to how the filtering electron magnifying lens functions (and this is the sharp piece) is that the pillar checking the example surface is precisely synchronized with the spot in the screen that the administrator is viewing. The electron identifier controls the brilliance of the spot on the screen - as the locator "sees" more electrons from a specific component, the screen shine is expanded. At the point when there are less electrons, the spot on the screen gets darker. Nowadays, the screen is by and large an advanced screen, not a glass crt, but rather the standard is the same. The amplification of the picture is the proportion of the measure of the screen to the span of the territory checked on the example. In the event that the screen is 300 mm crosswise over and the filtered zone on the example is 3 mm over, the amplification is x100. To go to a higher amplification, the administrator filters a littler zone; if the checked region is 0.3 mm over, the amplification is x 1000, soon.

4.3 X-RAY Diffraction

XRD examination depends on valuable impedance of monochromatic X-beams and a crystalline example: The X-beams are created by a cathode beam tube, sifted to deliver monochromatic radiation, collimated to focus, and coordinated toward the example. The cooperation of the episode beams with the example produces useful obstruction (and a diffracted beam) when conditions fulfill Bragg's Law ($n\lambda=2d \sin \theta$). This law relates the wavelength of electromagnetic radiation to the diffraction point and the grid dispersing in a crystalline example.

The trademark x-beam diffraction design created in a run of the mill XRD investigation gives an interesting unique finger impression of the precious stones display in the example. At the point when appropriately deciphered, by examination with standard reference examples and estimations, this unique mark permits recognizable proof of the crystalline frame.

4.4 Water Absorption

Water absorption is utilized to decide the measure of water consumed under determined conditions. Elements influencing water retention include: sort of plastic, added substances utilized, temperature and length of introduction. The information reveals insight into the execution of the materials in water or sticky situations.

For the water absorption test, the examples are dried in a oven for a predefined time and temperature and after that set in a desiccators to cool. Promptly after cooling the examples are weighed. The material is then emerged in water at settled upon conditions, frequently 23°C for 24 hours or until balance. Specimens are expelled, tapped dry with a build up free material, and weighed..

4.5 Biodegradable Test

Biodegradation is a sort of movement of occasions amid which materials are disintegrated artificially by microbes or some other natural ways. Most biodegradable issue comprises of natural materials produced from plants, creatures or counterfeit substances which are sufficiently comparable to plant and creature matter. Here are utilizing PBS answer for biodegradable test. Phosphate supported saline (PBS) is a cradle arrangement usually utilized as a part of natural research. The cushion keeps up a steady pH. For the most part a pH of 7.4 is kept up. The particle centralizations of the arrangement more often than not coordinate those of the human body.

Weight loss = Initial weight – Final weight.

5. RESULTS AND DISCUSSION

5.1 Tension Test for Chitosan Banana Fiber

The figure 1 (a) and (b) shows the tensile specimens of chitosan banana fiber before and after the test. It is observed that chitosan-banana fiber is a polymer material, and the fracture is a ductile fracture.

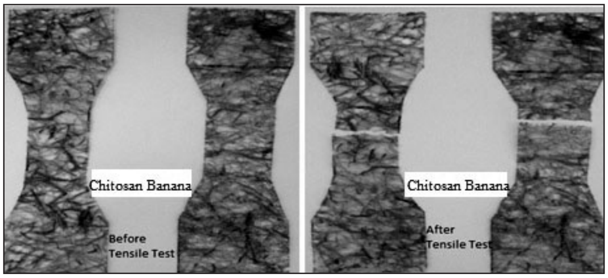

Fig 1 (a) & (b). Chitosan Banana Blended Film Specimen Before and After Tensile Test

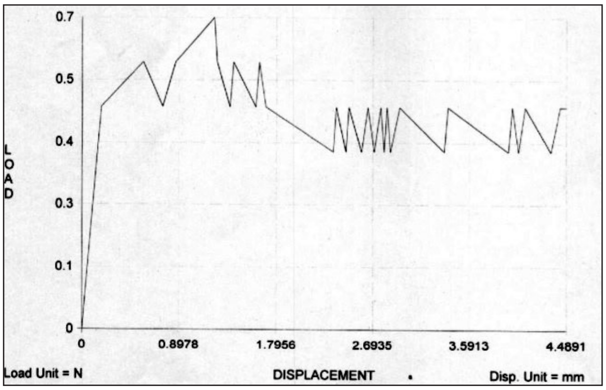

Fig 2. Graphical Representation of Load Versus Displacement for Chitosan Banana Blended Film-I Specimen

Table 1: Test Parameter and Test Results of Chitosan Banana film-I

Sl no.	Test Parameters	
1	Peak Load	0.7 N
2	Peak displacement	1.222 mm
3	Peak Displacement %	4.888 %
4	Eng. UTS	0.091 N/sq mm

The plotted graph Fig 2 shows the load versus change in length of the chitosan-banana fiber-1 specimen considered. It is observed that initially when the load is increased, the stress is directly proportional to strain. Beyond the proportional limit, the slope of the graph starts decreasing and the material attains fracture. The stress at the maximum load 0.7N is 1.222 mm peak displacement. When the load is increased the material gets fail at a break load of 0.0 N. Table 1 shows the test parameter and test results of chitosan banana film-I.

The plotted graph Fig 3 demonstrates the load versus change in length of the chitosan banana fiber-II examples considered. It is watched that at first when the load is expanded, the pressure is straightforwardly relative to strain. Past as far as possible, the incline of the chart begins diminishing and the material accomplishes break. The worry at the most extreme load 0.5 N is 3.327 mm top uprooting. At the point when the load is expanded the material gets fizzle at a break load of 0.0 N. Table 2 shows the test parameter and test results of chitosan banana film-II.

The tensile test was led utilizing all inclusive testing machine (UTM) and plotted the chart stack versus dislodging and organized the greatest rigidity can withstand by chitosan banana mixed film-I, the worry at the greatest load 0.7 N is 1.222 mm pinnacle relocation. At the point when the load is expanded the material gets fall flat at a break heap of 0 N. For chitosan banana mixed film-II, the worry at the most extreme load 0.5 N is 3.327 mm crest dislodging. Tensile test shows the point when the heap is expanded the material gets come up short at a break load of 0 N.

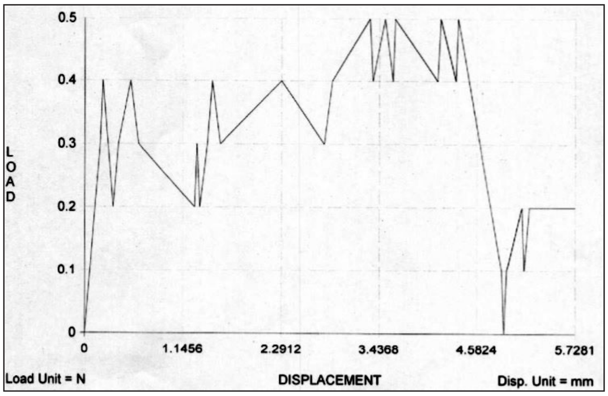

Fig 3. Graphical Representation of Load Versus Displacement for Chitosan Banana Film-II

5.2 Morphological Study of Chitosan Banana Fiber

The SEM pictures of Chitosan banana fiber are given in Fig 4(a) demonstrated the arbitrary plan of filaments and the nearness of less voids at first glance. The small strands in Fig 4(b) affirmed the expansion of chitosan demonstrates the best minimized capacity between them. The stacked game plan of strands and extensive thickness of the film. . It was watched that unit of fiber from grid was less in chitosan-mercerized banana fiber films. SEM may have shown of extensive interfacial bond amongst chitosan and banana fiber.

Table 2: Test Parameter and Test Results of Chitosan Banana Fiber-II

Sl no.	Test Parameters	
1	Peak Load	0.5 N
2	Peak displacement	3.327 mm
3	Peak Displacement %	13.306 %
4	Eng. UTS	0.070 N/sq mm

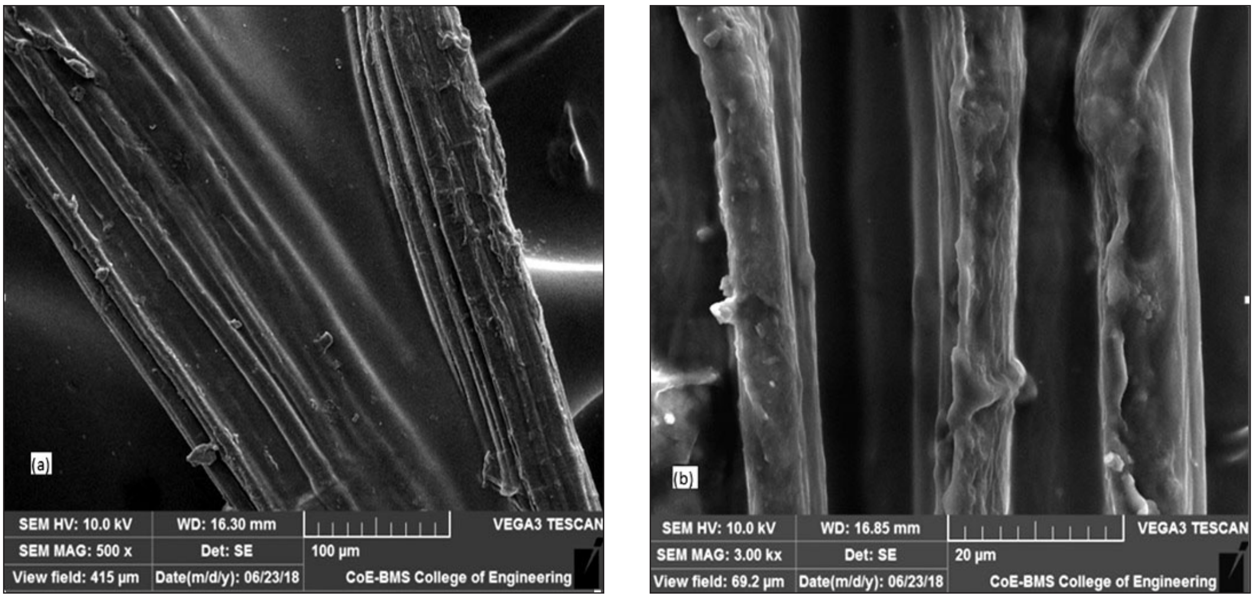

Fig 4 (a) and (b). SEM Images of Chitosan-Banana Film

5.3 X-Ray Diffraction Study of Chitosan Banana Fiber

The XRD example of Chitosan banana fiber film is given in figure 5. The one powerless expansive crest around 2ϴ= 20.6° and another solid crest around 2ϴ= 29.5° was watched. The pinnacle of 2ϴ peaks with red line which compared to calcite [Ca(co$_3$)] totally in the Chitosan banana fiber film..

5.4 Water Absorption study of Chitosan-banana Fiber

The water absorption study chitosan-banana fiber films are given in the percentage of weight are presented in figure 6. It was observed that the film lost its weight to some extent due to the presence of chitosan which is hydrophilic in nature. The weight loss was more in chitosan film, due to the presence of higher amount of chitosan. The loss of weight while soaking in water may due to the leaching of trapped acetic acid used for film casting process. During repeated run, this weight loss/ any physical deformation was not observed.

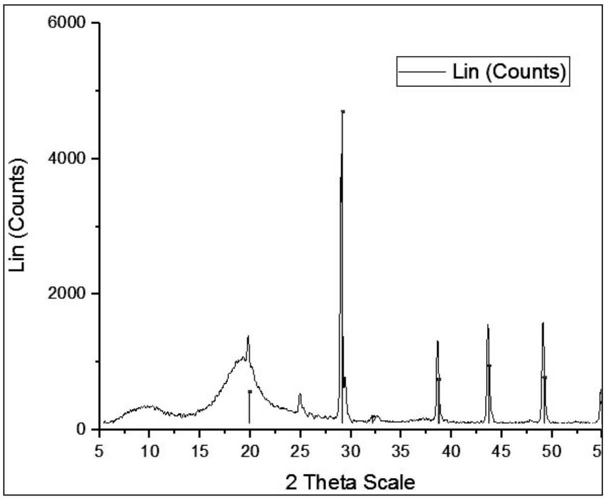

Fig 5. XRD Pattern Chitosan Banana Fiber Film

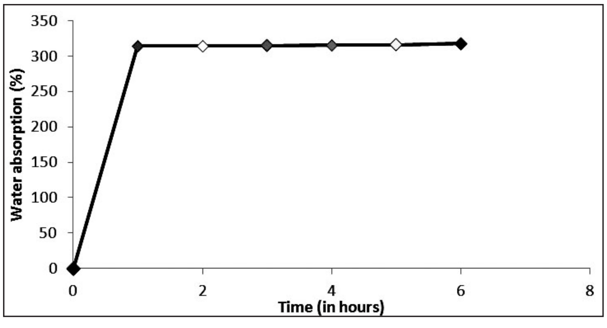

Fig 6. Graphical Representation of Water Absorption (%) Versus Time (hours) for the Chitosan-Banana Blended Film Specimen

Table 3: Readings Taken for Biodegradable Test

Days	Weight the of specimen	Weight loss of specimen in grams
1	0.1898	0.0000
2	0.18965	0.00015
3	0.1896	0.0002
4	0.1895	0.0003

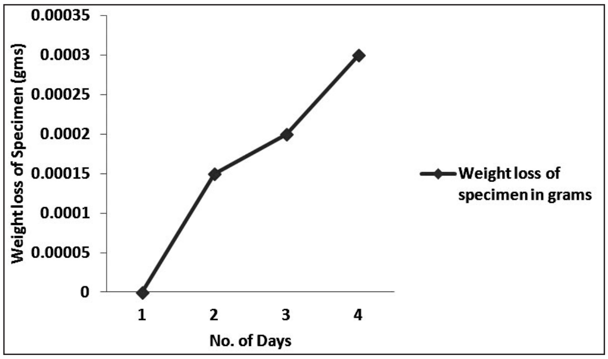

Fig 7. Graphical Representation of Weight Loss Versus Days for the Chitosan-Banana Film Specimen

The gradual increase of weight loss in the chitosan-mercerized banana fiber films was observed as the increase of concentration of NaOH during mercerization process. Weight loss was less for chitosan-banana blended film due to the partial removal of hemicelluloses and lignin content. In water absorption, it can be concluded that at the water uptake behaviour is high for chitosan banana blended film initially. After some time the rate of absorption decreases as compare to initial stage.

5.5 Biodegradable Test study

In biodegradable test we conveyed by utilizing Phosphate supported saline (PBS). It is a cushion arrangement generally utilized as a part of natural research. The support keeps up a steady pH. Specimen is biodegradable in nature. The rate of biodegradation is slow with chitosan banana mixed film. Initial weight of blended film specimen is 0.1898 grams. Table 3 shows the readings taken for Biodegradable test for four days and figure 7 shows the graphical representation of weight loss versus number of days for the Chitosan-banana film specimen.

6. CONCLUSION

In tensile test the point when the heap is expanded the material gets come up short at a break heap. At last we can presume that the pliable property for chitosan mixed film is superior. It was watched that the surface of the filaments demonstrated small scale fibrillation which was accomplished through mercerization demonstrated the smooth morphology of the fiber in the film. In XRD, it was noticed that the frail cooperation strands was seen because of the extraordinary unpleasantness of chitosan banana fiber. In water absorption, it can be concluded that at the water uptake behaviour is high for chitosan banana blended film initially. After some time the rate of absorption decreases as compare to initial stage. The rate of biodegradation of chitosan is more contrast with chitosan banana mixed film.

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