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Preparation of Chitosan-Polyvinyl Alcohol Blends and Studies on Thermal and Mechanical Properties

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Abstract

Chitosan is a biopolymer, which is an amino polysaccharide derived from the N-deacetylation of chitin. It is a natural polymer because of the presence of degradable enzyme Chitosan. Chitosan is blended with synthetic polymer PVA with formaldehyde enhances the thermal stability. Thermogravimetric analysis was conducted to measure the weight loss of the above mentioned blend systems at a heating rate $10^{o}Cmin^{-1}$ in nitrogen atmosphere. It is evident that formaldehyde is acting as a cross linker for Chitosan-PVA blend which have high thermal degradation or high thermal stability when compared with Chitosan-PVA-glycerol and Chitosan-PVA blends. The presence of cross linking agents like formaldehyde decreases the solubility to certain extent, and also increases the thermal stability due to the presence of aldehyde (-CHO-) group in the formaldehyde, forming cross links with amine(-NH2-) group present in the Chitosan. This reaction is based on the Schiff's base mechanism. Various compositions of Chitosan-PVA blends have been studied for its thermal and mechanical properties. The mean tensile strength and percentage elongation of Chitosan-PVA blends decreases with decrease in PVA content. But on addition of glycerol on to the blends of Chitosan-PVA, the percentage elongations increase and mean tensile strength decreases.

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*Keywords:*Cross linker, Thermal stability, Tensile strength, Elongation

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1. Introduction

Biopolymers are abundantly available from its natural sources of extraction. A few major group of biological composition includes polysaccharides, proteins, lipids and others[1]. Among them polysaccharides like cellulose, chitin and Chitosan are commonly applied. Chitin and Chitosan are the second most available biopolymer after cellulose. They are sourced mainly from exoskeleton of crustaceans such as shrimp also available from other sources such as fungi and some insect's wing. It is well known having common properties of poly saccharides such as biocompatibility, biodegradability, non-toxicity and antimicrobial as well as hydrophilicity. This made Chitosan is a very useful compound in wide range of applications in medical, pharmaceutical, chemical, agriculture and environmental fields. Chitin and Chitosan is naturally abundant polymer and renewable polymers have excellent properties like non toxicity, biodegradability, and adsorption. The reaction of Chitosan is considerably more versatile than cellulose due to the presence of NH_2 group. Natural polymers have attracted an increasing attention over the past two decades, mainly due to their abundance and low cost. The high sensitivity to moisture is one of the limitations to the application of Chitosan film in packaging applications[2].

Chitin and Chitosan are amorphous solid biopolymers that are almost insoluble in water. Chitosan is soluble in Organic acids like1% acetic acid, formic acid, adipic acid, formic acid, lactic acid, malic acid, prop ionic acid or succinic acid. Solubility in mineral acids is limited. It is soluble only within acid concentrations ranges from 0.15 to 1.1%. It is insoluble in phosphoric or sulphuric acid and in neutral or alkaline media. Polyvinyl Alcohol (PVA) is nontoxic, water –soluble synthetic polymer, which is widely used in polymer blends because of its good physical and chemical properties and excellent film forming characteristics and emulsifying capability[3]. Its use is important many applications such as controlled drug delivery systems, membrane preparations, recycling of polymer and packaging etc. The property of bio inertness makes it useful in medical applications such as artificial pancreas, hemo dialysis, nanofilteration and implantable medical devices.

Chitosan exists in form of white yellowish flakes, which can be converted to bead or powders. Degree of Deacetylation (DD) plays vital role on molecular weight of Chitosan lower DD higher the molecular weight providing higher chemical stability and mechanical strength. It has a cationic nature due to presence of amino and hydroxyl group and has strong positive charge because of presence of large amino group. It is a rigid polymer due to presence of hydrogen bonding and reactive hydroxyl groups available in the structure. It is also a biocompatible, antibacterial, biodegradable, bacteriostatic/fungi static, safe and non-toxic polymer which make it applicable in food industry and medical applications. The addition of cross linkers and plasticizers to carbohydrates films has been widely studied as a means of improving textural properties. The most studied plasticizing agent in carbohydrate films has been glycerol. Its efficacy in increasing film punctures deformation. Glycerol can be used at relatively low concentration to achieve significant plasticizing properties. Glycerine is a material of outstanding utility with many areas of application. The key to glycerine's technical versatility is a unique combination of physical and chemical properties, ready compatibility with many other substances, and easy handling. Glycerine is also virtually nontoxic to human health and to the environment physically, glycerine is a water-soluble, clear, almost colourless, odourless, viscous, hygroscopic liquid with a high boiling point. Formaldehyde is a used as a cross linking agent. Its small molecules (HCHO, of which the -CHO is the aldehyde group) dissolve rapidly in water, with which they combine chemically to form methylene hydrate, $HO\text{-}CH_2\text{-}OH$.

1.1 Objective of the study

- To prepare Chitosan-PVA blends.
- To study thermal stability of Chitosan-PVA blends cross linked with formaldehyde.
- To study mechanical properties of Chitosan-PVA blends plasticized with glycerol

2. Materials and methods

2.1. Chemicals used

85% degree of deacetylated Chitosan is brought from India sea foods, Thoppupady, Cochin. Glacial acetic acid is an aqueous solution clear and colourless, pH=2.4, molar mass=60.05g/mol, density1.05g/cm^3 brought from Medilise chemicals, Kannur.1% acetic acid is prepared by mixing 1ml glacial acetic acid with 99ml water. Poly vinyl alcohol (500gm) brought from (spectrum reagents and chemicals pvt. Ltd. Edayar, Cochin) Degree of polymerization =1700-1800 and pH of aqueous solution 5-7.