ABSTRACT

In recent years, protein based materials have gained immense importance due to their wide range of functionality in different areas including packaging, drug delivery systems, and bioelectronics. The physicochemical properties of protein films mostly depend on the amino acid sequence, quantity and their arrangements within the source protein. In this thesis, we have employed and investigated a novel source of protein for the preparation of protein films. The aspirated emulsion obtained after cataract surgery has been termed as the cataractous eye protein isolate (CEPI). Since the eye lens is composed of 90 % crystallin proteins, this aspirated emulsion contains a large amount of proteins, which is discarded as waste. Designing biomaterials using this discarded yet highly rich source of protein could have wide range of applications. The main aim of this thesis is to explore the film forming properties of CEPI in the presence of various external additives.

The cataractous eye protein isolate has been purified by freeze drying and dialysis. Initial characterization of CEPI has been carried out by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) and Matrix-assisted laser desorption ionization-Time of Flight (MALDI-ToF). The films have been characterized using different spectroscopic, microscopic, thermal and mechanical testing methods. The film forming ability of CEPI has been investigated by employing glutaraldehyde (GD) as a cross-linker and glycerol as a plasticizer. The films demonstrated improved mechanical, thermal and physical properties like extent of soluble matter and possess a comparable Young's modulus value with the films made of collagen, zein protein. The cross-linked films show good delivery properties for compounds such as ampicillin sodium (Amp-Na) and curcumin. The *in-vitro* release profile showed a biphasic pattern with an initial burst release followed by a slow and sustained release of the loaded compound. The antibacterial test of the release aliquots has been studied using an agar disk diffusion test in which it exhibited an appreciable inhibition against *Staphylococcus aureus*. Since glutaraldehyde is toxic in nature, the film forming properties of CEPI have been further explored using a small molecule gallic acid (GA), a skeleton moiety presents in many naturally occurring phenolic compounds. The films were found to exhibit superior mechanical properties over the films made of soy, canola and casein protein cross-linked with popular cross-linkers. GA cross-linked films have significant antioxidant characteristics determined from a 2,2-diphenyl-1-picrylhydrazyl (DPPH) assay. All cross-linked films including the GD cross-linked films are found to be degradable by the application of trypsin. The plasticization of protein has a vital impact on the protein film network. The effects of plasticizers on CEPI have been studied using glycerol (GL), polyethylene glycol (PEG 400) and sorbitol (SOR). GL was found to be the most effective plasticizer due to its small size and hydrophilic nature. The role of CEPI in the synthesis of silver nanoparticles (AgNPs) has been investigated and it showed a reducing as well as stabilizing effect in preparation of AgNPs. The nanoparticles have also been known to strengthen the protein network. The AgNPs have a significant impact on the film forming properties of CEPI. Moreover, the nanocomposite films exhibited biocompatibility with RBCs and the skin fibroblast cells with an antibacterial effect against *E.coli*. In addition, we have explored the effect of CEPI on polydimethyl siloxane (PDMS) to investigate its dielectric properties under different conditions. This has shown interesting properties in terms of dielectrics. The research presented in this thesis opens up the possibilities to fine-tune CEPI and other waste proteins for a multitude of applications.

Keywords: Protein films, cataractous eye protein isolates, cross-linker, plasticizer, drug delivery systems, biodegradability, biocompatible, silver nanoparticles, polydimethyl siloxane, dielectrics