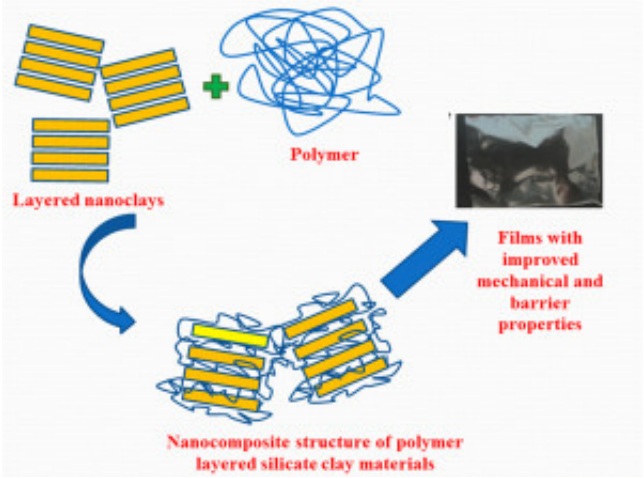
Biodegradable packaging films with improved mechanical and barrier properties

Conventional plastics pose major threat to environment because they are non - biodegradable and are derived from non - renewable resources. Despite this demand for conventional plastics has been rising steadily over the years. It is estimated that worldwide demand for plastics is 295 million metric tons (MMT) of which approximately 39 percent is from packaging industry. Due to major environmental problems caused by use of conventional plastics there is an urgent need to develop alternative form of materials that are amenable for packaging and at the same time biodegradable and recyclable. In this regard various researchers have developed plastics using natural biopolymers such as proteins, lipids and polysaccharides which are biodegradable, non-toxic and completely renewable. However, packaging materials derived from natural polymers have relatively poor mechanical and barrier properties such as tensile strength and water vapor transmission rate as compared to petroleum based materials which limits their commercial applications. This has resulted in a greater focus on improving the properties of these polymers to match the commercially available packaging material. Various chemical and physical methods have been used for improving biopolymer film properties. Among the physical methods, addition of plasticizer for improving mechanical properties of biodegradable films has been extensively reported. Chemical modifications of natural polymers have also been attempted by several researchers to improve their properties. Apart from these use of physical treatments such as gamma radiation has also found applications in improving quality of natural polymers based packaging materials. Processing by gamma radiation involves exposing films to high energy radiations in a controlled manner which can lead to crosslinking among polymeric chains thus improving mechanical and barrier properties.



In present publication, biodegradable packaging films were developed using guar gum which is obtained from endosperm of legume plant Cyamopsis tetragonoloba. It is a hetropolysaccharide of a mannose (i.e. (1-4)-linked ?-d-mannopyranose) backbone with galactose side groups

((1-6)-linked ?-d-galactopyranose) and is widely used in food, pharmaceutical and paper industries. To improve mechanical and barrier properties of prepared films nanocomposites were prepared using nanoclays with guar gum. Natural inorganic montmorillonite (MMT) and organically modified clay (closite 20A) was used in present work. MMT consists of inorganic layered silicates several hundred nanometers long having layer spacing of few nanometers. The size range of nanoclay is around 100 nm and it has two tetrahedral sheets of silica sandwiching a central octahedral sheet of alumina. Nanoclays were first dispersed in distilled water for seven days using a magnetic stirrer. After seven days guar gum and glycerol were added and were properly mixed for 24 h using a magnetic stirrer. This homogeneous solution was then poured evenly on glass plate and dried at 80 °C for 8 h. Films formed were conditioned at 50 percent relative humidity for seven days and then subjected to mechanical and barrier properties testing. A nanoclay concentration dependent increase in mechanical strength and reduction in water vapor transmission rate was observed. Films containing nanofil 116 (2.5% w/w guar gum) and closite 20A (10% w/w guar gum) demonstrated a 102% and 41% higher tensile strength, respectively, as compared to the control. Lower tensile strength of cloisite 20A films as compared to nanofil 116 films was due to its incompatibility with guar gum. X-ray scattering analysis revealed that interstitial spacing between nanofil 116 and cloisite 20A sheets increased due to intercalation by guar gum polymer. This resulted in improved mechanical and barrier properties of nano-composites compared to control. Films prepared were shown to have radiation stability thus demonstrating their suitability for food irradiation applications. These results show possibility of developing biodegradable plastic films having properties comparable to commercial counterparts using nanotechnology.

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