Modification of Edible Food Packaging Materials Based on Natural Polymer Blends by Ionizing Radiation

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BY

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ABSTRACT

Blends based on different ratios of plasticized starch (PLST), poly (vinyl alcohol) (PVA) and carboxymethyl cellulose (CMC) were prepared by solution casting in the form of thin films. The PLST/PVA and PLST/CMC films were exposed to different doses of gamma radiation. The effect of gamma-irradiation on the thermal, mechanical and structure morphology properties was investigated. As an application in the field of the prolongation of food preservation life time, Mango fruits were coated with solutions of gamma-irradiated PLST/PVA and PLST/CMC blends in the presence of chitosan, as an antimicrobial material, to form thin films. The results showed that the gamma-irradiation improved all the physical properties, which provides suitable materials based on natural biodegradable polymers for food preservation withstanding the temperature and stresses.

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AIM OF THE WORK

Poly (vinyl alcohol) (PVA) is a non-toxic, water-soluble polymer which has good film forming and has a highly hydrophilic properties, while Carboxymethyl cellulose (CMC) is a polymer has a significant swelling capacity, non-toxicity, unique reactivation, hydrophilicity, molecular characteristics, and widely used in the pharmaceutical industry, Starch, on the other hand, is a naturally occurring polymer, low effective cost, and easy to handle. The blending of naturally occurring polymers like starch into other polymeric materials could provide biodegradable materials. In this regard polymer blend based essentially on incorporation of starch into the PVA, CMC matrix changes the physico-mechanical properties of the material and thus modifies the polymer structure at both the molecular and the morphological levels, irradiation of polymer blends can be used to crosslink or degrade the desired component polymer, or to fixate the blend morphology. The present work is undertaken to study the effect of gamma irradiation on the structure–property behavior of polymer blends based on various ratios of plasticized starch and poly (vinyl alcohol), plasticized starch and CMC. This study aims basically to use these blends in film industry as an edible coating material for food preservation.

CHAPTER I
INTRODUCTION AND LITERATURE REVIEW

1.1. Effect of Ionizing Radiation on Polymeric Materials

Chmielewski (2004) reported that the radiation technologies applying gamma sources and electron accelerators for material processing are well-established processes. The technologies to be developed besides environmental applications could be nanomaterials, structure engineering materials and natural polymers processing.

Wilson (1974) reported that the ionizing radiation covers different types of radiation, such as electromagnetic waves, X-rays and γ-rays from radioisotopes (cobalt-60 and cesium-137). Also β-rays and electron beams generated by electron accelerators. Heavy particle radiations (e.g. alpha, accelerated deuteron and heavier ions) and neutron beams may be used for special purposes. It can be easily seen that there are generally undetectable differences in the effects produced by electrons and gamma rays at equal doses. Fast moving electrons lose their energy through electrostatic interaction with the electrons of irradiated medium. If energy transferred from the incident particles is higher than the binding energy of the electrons in the molecule, an electron may be ejected leaving behind a positively charged "ionized" molecule. If the amount of energy transferred to the molecule is less than its lowest ionization potential, electronic excitation may occurring giving rise to an excited state, which may or may not dissociate further into free radicals.

The two most common radiation types in industrial use are gamma and electron beam. The gamma facilities are mainly cobalt-60 **(Clough, 2001).** The advantages of gamma radiation over other types include the fact that gamma rays are very penetrating. The technology is extremely simple, so there is low downtime for a gamma source. In addition, it is not sensitive to electricity prices. Gamma sources are most commonly used today for radiation sterilization of disposable plastic medical items **(Halls, 1991).**

Electron beam machines play a significant role in the processing of polymeric materials; a number of different machine designs and different energies are available. Industrial electron beam accelerators with energies in the 150–300 MeV range are used in applications where low penetration is needed, such as curing of surface coatings **(Berejka, 1993)**. Accelerators operating in the 1.5 MeV range are used where more penetration is needed, as in the cross-linking of cable insulation. High-energy commercial electron beams, operating in the 10 MeV range, are used for applications such as sterilization of boxes filled with disposable medical devices **(Descamps, 1995)**. Elecron beam machines have a high-dose rate and therefore short processing times. While they have limited penetration compared with gamma, they conversely have good utilization of energy due to the following aspects: (1) all can be absorbed by the sample being irradiated. (2) Can be switched off when it is not in use. (3) They contain no radioactive isotope; this provides an advantage from a public acceptance standpoint. (4) No radioactive material is disposed off when the facility is decommissioned.

1.1.1. Interaction of Radiation with Polymeric Materials

Bhattacharya (2000) reported that radiation technology is preferred over the other conventional energy resources due to some reasons, e.g. large reactions as well as product quality can be controlled, saving energy