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ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ASIAN JOURNAL
ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 4, Issue 07, pp.039-041, July, 2013

RESEARCH ARTICLE

TECHNIQUES OF PREPARING EDIBLE PROTEIN FILMS: REVIEW

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ARTICLE INFO

Article History:
Received 24th April, 2013
Received in revised form
04th May, 2013
Accepted 09th June, 2013
Published online 19th July, 2013

Key words:
Bio packaging, Protein,
Techniques, Properties,
Applications.

ABSTRACT

In recent days human beings are much concerned about healthy environment. They are becoming health conscious too, which lead to disposal of synthetic polymers based food packages and acceptance of bio packaging. Scientists and researchers are working on developing such bio packaging. These types of bio packages can be made from various types of biopolymers like polysaccharides; proteins and lipids. Protein based bio packages are mostly accepted because of its high degradability and their ability to supplement nutritional value to food products. Here in this review we are going to focuss on the techniques applied to make such protein based films, assessment of physical, mechanical, thermal, barrier and antimicrobial properties and also their applications in packaging food products.

INTRODUCTION

Any type of materials used for enrobing (i.e. coating or wrapping various foods to improve their shelf life that may be eaten together with food with or without removal, is considered as an edible film. It provides replacement and fortification of natural layers to prevent moisture losses, while selectively allowing for controlled exchange of important gases such as oxygen, carbon dioxide, and ethylene, which are involved in respiration process. A variety of renewable biopolymers such as polysaccharides, proteins, lipids and their composites derived from plants and animal resources have been investigated for the development of edible biodegradable packaging materials to substitute for their non biodegradable petrochemical based counterparts. This review focuses on the techniques for production either by wet process or dry process, analysis of the film properties and applications in food products packaging.

Plant protein like soya protein isolates (Tang *et al.*, 2005), wheat protein blend along with corn protein (Gennadios *et al.*, 1990), pea protein (Choi *et al.*, 2001), peanut protein isolates (Liu *et al.*,, 2004), lentil (Bamdad *et al.*, 2006) and faba bean protein isolate (Saremnezhad *et al.*, 2011) are so far used to develop edible films. Animal based protein films so far noted are egg albumin (Prospero Di Pierro, 2006),whey protein (Oses, *et al.*, 2009), squid gelatin (Gimenez, *et al.*, 2009), soya protein and cod gelatin blend film (Denavi *et al.*, 2009), films from cat fish and triacetin mixtures (Jiang, M., Liu *et al.*, 2010), β-lactoglobulin films (Sundaresan *et al.*, 2008),muscle proteins of Blue Marlin (Hamaguchi *et al.*, 2007).

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Chitin (exoskeleton of crustaceans) often blended with polysaccharide films for enhanced mechanical and antimicrobial properties (Marcia R.de Moura *et al.*, 2008).

Techniques used in preparing protein based films

Films can be prepared by wet process thus dissolving biopolymers in solvent (water, alcohol, or organic solvent) along with especially non-ionic stabilizer or plasticizers (Casariego *et al.*, 2008) further stirring and heating on hot plate stirrer and thereby at adjusted pH. Later on the film forming solution was casted on petriplates covered with Mylar (de Moura *et al.*, 2009) or on Teflon coated glass (Saremnezhad *et al.*, 2011). This wet process is known as solution casting method .These film forming solutions are either dried at room temperature for 24 hrs or even dried by applying vacuum (L. Shi. S. Gunasekaran 2008) or compress mould (Sothornvit *et al.*, 2007). These protein films can also be prepared by dry process by melt mixing (Li-xue Xiang *et al.*, 2009) thermoplastic biopolymers later on cooling them into film form. Recently melt extrusion process is adapted in making such edible films. By melt extrusion technique composites can be processed from the blend of soya protein isolate and nanoclay like Montmorillonite clay (Kumar *et al.*, 2010). The flow diagram of melt extrusion technique (Fig.1).

Characterizations of Protein Films and Their Blends

The processed protein films are characterized so as to ascertain their mechanical, water, barrier, gas barrier, thermal, antimicrobial properties so that they can be applied in food products packaging. The structure digital micrometer and morphology of the films are studied by Transmission Electron Microscopy (TEM) and the morphology of the fractured surface (cross–sectional surface) is studied by Scanning Electron Microscopy (SEM) (Gunasekaran, 2008).

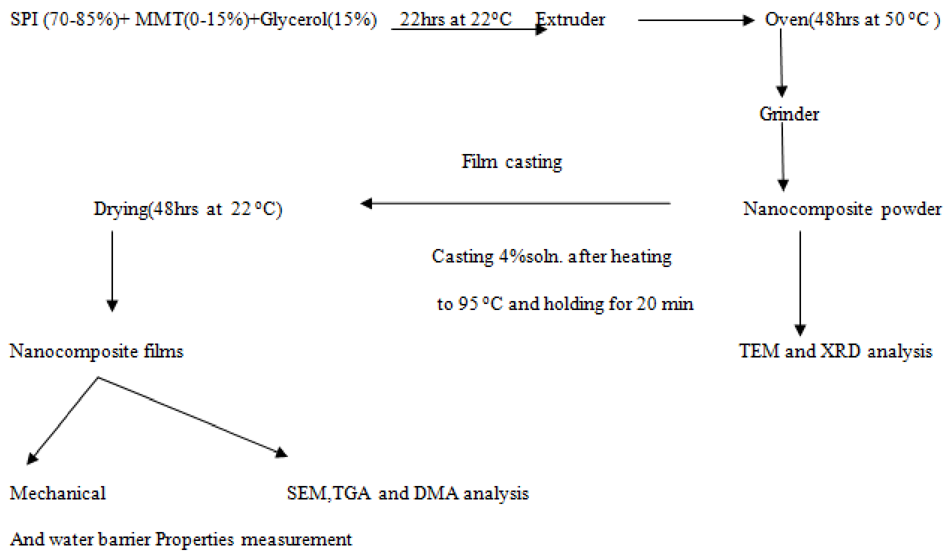

Fig. 1. The flow diagram of melt extrusion technique

Film thickness is to be measured by digital micrometer, Hunter colour parameters is to be measured by Color flex (change of colour values are determined by comparing total colour difference of the films, mechanical properties like tensile strength (TS) and percent elongation at break are to be measured with texture analyzer and total soluble matter of films also measured (Saremnezhad *et al.*, 2011), water vapour permeability of the films is to be measured by the standard ASTM method E960 (ASTM. 2000) oxygen permeability i.e. exchange of gases is also to be measured (MOURA *et al.*, 2008),recent review stated that UV-vis spectrum, FTIR analysis of the films are very important in characterization study (Tripathi, *et al.,* 2011). The earlier review also revealed the importance of the antibacterial activity of the chitosan blended biopolymer based films against the food borne disease causing bacteria like, *E.coli, B.subtilis, P.aeruginosa and S.aureus*. Among all the characterizations another two very important analysis are the statistical analysis (Mauria. R. De. Moura *et al.,* 2009) and food contact tests are essential in food packaging applications (Avella *et al.,* 2005).

Modifications of protein films

Potential chemical methods of modifying the properties of protein based films include pH changes (Kumar *et al.,*, 2010), salt addition (Park *et al.,* 2001), chemical modification of side chains of peptides, cross-linking and hydrolysis of peptides. In order to improve the mechanical properties and water resistance, biopolymers like starch has been modified by blending with synthetic or natural polymers by cross linking. Recently studies on properties of Soy protein isolate films blended with carboxymethyl cellulose and cross linked by Maillard reaction is reviewed (Su, *et al.,* 2010). One of the most widely used methods for improving the moisture barrier properties of biopolymer films is to include additives that are hydrophobic in nature. Lipid materials such as neutral lipids, fatty acids or waxes can be incorporated to improve barrier properties of such protein based films. The use of natural materials like cellulosic fibers and minerals have been considered to improve mechanical properties without interfering in biodegradability of the composite films.

Recently a new class of materials represented bio nano composites (biopolymer matrix including protein reinforced with nano particles such as montmorillonite) has proven to be a promising option in improving mechanical and barrier properties of biopolymers. The most common class of materials used as nano particles are layered clay minerals such as hectorite, saponite, and laponite (Rhim *et al.,* 2009). These clay minerals have been proven to be very effective due to their unique structure and properties. MMT has very high modulus and enables to improve mechanical properties of biopolymers by carrying a significant portion of the applied stress. Previous review also stated that chitosan (an acetylated polysaccharide derived from chitin of the exoskeleton of the crustaceans) can also be used as fillers by forming chitosan nano particles and incorporated into hydroxymethylcellulose (HPMC) films so as to improve the mechanical and barrier properties of those films. (MR DE MOURA *et al.,* 2008). Different types of nanomaterials like copper, zinc, titanium (Retkukiman-Schables *et al.,* 2006), magnesium, gold (Gu *et al.,* 2003), alginate (Ahmed *et al.,* 2006) and silver have come up, but Silver nitro phosphates have proved to be most effective as they have good antimicrobial efficacy against a wide variety of bacteria, virus and eukaryotic micro-organisms. From recent review it is reported that chitosan-silver oxide nano composite films show good antimicrobial activity against food borne disease causing bacteria like *E.coli, Staphylococcus aureus, Bacillus subtilis, Pseudomonas aeurogenosa,* to improve microbial food safety and food quality (Mauria R. De. Moura *et al.,* 2009).

Future Trends of Developing Edible Protein Based Films with Enhanced Mechanical and Barrier Properties

As per recent review edible films can be processed from faba bean (Vicia faba) protein isolates, so similar protein isolate films can be processed from various edible other than soybean. Keeping in mind the protein content and amino acid profile; sunflower, sesame, mustard seed protein isolate films incorporated with nanofilers can certainly be tried out. Fish protein isolate from low cost fishes can also be manufactured. Wheat gluten along with silica and alumina can form bio nano composites (Sudsiri, Hemsri *et al.,* 2011). Films should be characterized and the food contact tests are need to be highlighted along with the microbiological test i.e. antimicrobial activity. Emphasis can also be given on the blended films with other biopolymers along with nano filers (Zhao *et al.,* 2008).

Conclusion

Previous reviews help to get more ideas on the technology development of nano laminates preparation process from proteins and other biopolymer blended films .On the basis of the previous work done, the process of technology can be improved by altering some methods or changing some conditions to get much better results than that of the previous ones. Some new biopolymers other than the common ones are to be chosen keeping the basis of the technology same so as to get more improved mechanical properties, barrier properties and also antimicrobial activity.

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