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REVIEW ARTICLE

A review of biopolymer chitosan blends in polymer system

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ABSTRACT

Blending of two or more polymers to obtain materials with new and unique properties has become one of the most important research in the field of polymers. The main purpose of blending the polymers is to obtain materials of additional properties with minimum sacrifice of their original properties.
Chitosan is the most abundant natural amino polysaccharide and is estimated to be produced annually almost as much as cellulose. It has become of great interest not only as an underutilized resource, but also as a new functional material of high potential in various fields, and recent progress in chitosan chemistry is quite noteworthy. The purpose of this review is to take a closer look at Nylon 6 and chitosan applications. Based on current research and existing products, some new and futuristic approaches in this fascinating area are thoroughly discussed.

KEYWORDS

Chitin,
Chitosan,
Nylon 6,
Cross linking,
Nano fibers

INTRODUCTION

Chitosan and its derivatives have received much attention from scientists in different parts of the world. Due to its natural abundance and versatility, many investigations have focused on its properties and various applications (Goy et al., 2009). Although studies on chitin and chitosan were initiated in the early nineteenth century, most of the reports available today on its medical and pharmaceutical applications have been obtained only during the last couple of decades (Goy et al., 2009).

Chitosan is a weak base and is insoluble in water, but soluble in dilute aqueous acidic solutions below its pKa (~6.3), in which it can convert glucosamine units (-NH2) into the soluble protonated form (-NH+3). The solubility of chitosan depends on its biological origin, molecular weight and degree of acetylation. Since chitosan is soluble in diluted acid solutions, films can be readily prepared by casting or dipping, resulting in dense and porous structure.

Chitosan film is regarded as biofunctional material, well tolerated by living tissues, particularly applicable as edible coatings to prolong shelf-life and preserve quality of fresh foods. In medical field, chitosan films have been tested as curative wound dressing and as scaffolds for tissue and bone engineering. In combination with synthetic polymers chitosan has lots of applications.

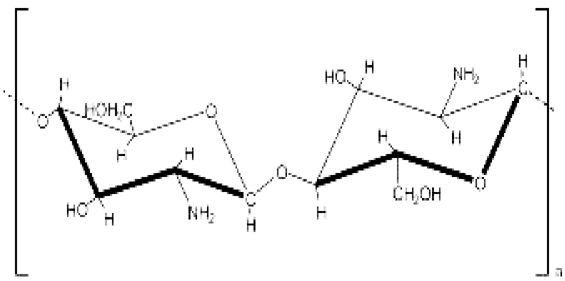

Figure 1 : Structure of Chitosan

The objective of our research is to extend the biomedical applications of chitosan by blending it with nylon 6. Nylon-6 is a semi-crystalline polymer that is stabilized by hydrogen bonds involving amide groups. As nylon 6- $[-NH(CH_2)_5\ CO-]_n$ polymers have many uses as an engineered material because of its strong mechanical properties such as high tensile and impact strengths and abrasion resistance properties.

We have chosen these two polymers Nylon-6 and Chitosan because of their good intermolecular interactions. These blends of Nylon-6 and chitosan are more advantageous over the pure chitosan because of the mechanical biocompatibility, antibacterial and other properties can be drastically enhanced.

MATERIALS AND METHODS

Properties of chitin and chitosan

Chitin and its deacetylated derivative chitosan are natural polymers composed of randomly distributed β-(1-4)-linked D-glucosamine (deacetylated unit) and N-acetyl-D-glucosamine (acetylated unit). Chitin is insoluble in aqueous media while chitosan is soluble in acidic conditions due to the free protonable amino groups present in the D-glucosamine units. Due to their natural origin, both chitin and chitosan cannot be defined as a unique chemical structure but as a family of polymers which present a high variability in their chemical and physical properties. This variability is related not only to the origin of the samples but also to their method of preparation. Chitin and chitosan are used in fields as different as food, biomedicine and agriculture, among others.

A functional characterization of chitin and chitosan regarding some biological properties and some specific applications (drug delivery, tissue engineering, functional food, food preservative, biocatalyst immobilization, wastewater treatment, molecular imprinting and metal nanocomposites) is presented. The molecular mechanism of the biological properties such as biocompatibility, mucoadhesion, permeation enhancing effect, anticholesterolemic, and antimicrobial has been updated.

Preparations of Material

Commercially, chitosan is available in the form of dry flakes, solution and fine powder.

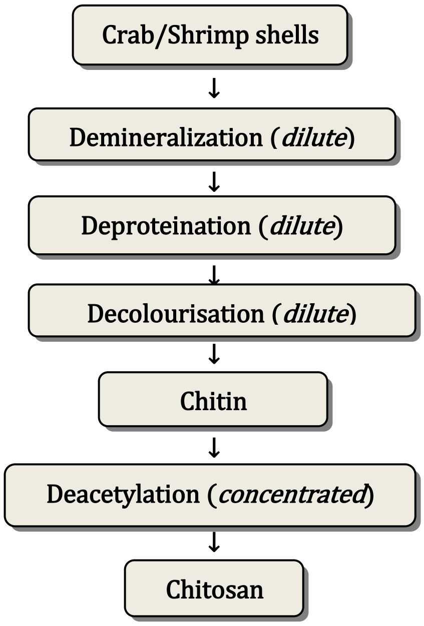

Figure 2: Chitosan production flow diagram.

The Antimicrobial Chitosan

Chitin and chitosan have been investigated as an antimicrobial material against a wide range of target organisms like algae, bacteria, yeasts and fungi in experiments involving in vivo and in vitro interactions with chitosan in different forms (solutions, films and composites). Early research describing the antimicrobial potential of chitin, chitosan, and their derivatives dated from the 1980-1990s.

Generally, in these studies the chitosan is considered to be a bacteriocidal (kills the live bacteria or some fraction therein) or bacteriostatic (hinders the growth of bacteria but does not imply whether or not bacteria are killed), often with no distinction between activities. Recent data in literature has the tendency to characterize chitosan as bacteriostatic rather than bactericidal, although the exact mechanism is not fully understood and several other factors may contribute to the antibacterial action.

Influence of the Degree of Acetylation and Molecular Weight

Several studies have shown that the biological activity of chitosan depends significantly on its molecular weight (MW) and degree of acetylation (DA). Both parameters affect the antimicrobial activity of chitosan independently, though it has been suggested that the influence of the MW. on the antimicrobial activity is greater than the influence of the DA (Rafeeq et al., 2010).

Biological properties

In this respect, chitosan have attained increasing commercial interest as suitable resource materials due to their favourable biological properties including biocompatibility, non-toxicity and biodegradability. Several bioactive properties such as blood cholesterol control, weight loss effects, anti-inflammatory, anti-tumor activity, dental plaque inhibition, bone healing treatment, wound healing accelerator, hemostatic, anti-viral, antibacterial activity, antifungal activity, delivery of immunomodulatory agents have been reported. Chitosan displayed a low oral toxicity with an LD50 in mouse of 16 g/kg bodyweight (RaviKumar, 2000). Side effects of chitosan following oral administration relate to its effects within the gastrointestinal tract (RaviKumar, 2000). Consumption of several grams of chitosan daily by humans can result in constipation or diarrhoea, because chitosan entraps water and lipids in the intestine (Buraidah et al., 2010). In man, in trials lasting for up to 12 weeks, no clinically significant adverse effects or changes in laboratory values relating to safety have been noted. Chitosan treatment had no effects on serum electrolyte levels or fat-soluble vitamin levels (Buraidah et al., 2010). The amounts of chitosan needed in pharmaceutical formulations are fairly low (less than 1000 mg/dose), and risks of side effects in the gastrointestinal tract are therefore also low (Buraidah et al., 2010). Although chitosan is clinically well tolerated, it has been suggested that it might not be desirable for administration to individuals allergic to crustaceans, in whom consumption of crustaceans frequently results in allergic reactions, and serious adverse reactions are possible (Inmaculada et al., 2009). On the other hand, chitosan has been widely used in nonmedical natural products. No information about allergic reactions relating to these products has been available. β-(1,4) glycosidic bond of chitosan will only be degraded by microfloral β-glycosidases in the lower part of the colon and result in non-toxic degradation products (Inmaculada et al., 2009).

Pharmaceutical Applications

The intriguing properties of chitosan have been known for many years and this polycationic polymer (in acidic environments) has been used in the fields of agriculture, industry and medicine.

Drug delivery system Colloidal systems have found numerous applications as promising delivery vehicles for drugs, proteins, antigens, and genes due to their low toxic side effects and enhanced therapeutic effects. Polymeric self-assembly systems, (SA's) are one type of colloidal system that has been widely investigated in terms of micellar behavior in the areas of biotechnology and pharmaceutics (Inmaculada et al., 2009).

Chitosan-Based Polymer Electrolyte Photovoltaic Cells

From the literature review it is observed when chitosan based polymers doped with salt enhance the conductivity of electrolyte.

It was found that the dielectric constant of polymer and lattice energy of salt influence the conductivity. The conductivity in turn affects the short-circuit current density of the solar cells (Minagawa et al., 2007).

CROSS LINKING

Blending of two or more polymers to obtain materials with new and unique properties has become one of the most important researched topics in the field of polymers. Blending of polyamides with various polymers has been an extensively researched topic in the last couple of decades1. The main purpose of blending the polymers is to obtain materials of additional properties with minimum sacrifice of their original properties.

The use of interfacial agents to compatibles polymer blends containing polyamides has gained considerable importance because of the presence of amide groups on the polymer backbone.

These groups readily react with acids. Bases and carbonyl groups(C=O). Reactive interfacial agents with such functional groups have been successfully used to compatibles the blends of polyamides with various polymers.

Blends of synthetic and natural polymers represent a new class of materials which have attracted much attention especially in bio application as biomaterial. The success of synthetic polymers as biomaterials relies mainly on their wide range of mechanical properties Blends are able to improve many properties such as mechanical and thermal properties (RaviKumar, 2000).

CONCLUSION

As we have shown in this review, chitin and chitosan present a great variety of properties, allowing them to have a large number of applications, but, at the same time, the very complex behaviour of these polymers is difficult to control.

These polymers have an intrinsic variability due to their natural origin. Moreover, depending on the manufacturing process, the properties of samples from the same source change. In general, a poor characterization of the polymers is carried out which makes it very difficult to compare results and to establish relationships between the physiological behavior of chitin and chitosan and their properties. However, from data in the literature it is possible to give general recommendations regarding the properties of chitin and chitosan for a specific application, this being the main contribution of this review to the field of study of chitin and chitosan.

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