Edible food packaging material

Edible polymers are the natural polymers (made from edible ingredients) that can directly be consumed by human beings or animals with no health risk.

Edible polymers are used to make edible films and coating. There is no specific difference between edible films and coatings in terms of material composition; only their thicknesses are different. Films are generally used in the production of wraps, pouches, bags, capsules and casings. On the other hand, coatings are applied directly on the food surface.

Edible coating are defined as the thin layer of material which can be consumed and provide barrier to oxygen, microbes of external source, moisture and solute movement for food.

The edible coatings are mainly divided into three classes

- Hydrocolloids e.g. polysaccharides, proteins and alginate
- Lipids e.g. fatty acids, acryl glycerides and waxes
- Composite e.g protein/protein, polysaccharides/protein, lipid/polysaccharides

Hydrocolloids

Hydrocolloids are originated from animals, vegetables, microbial or synthetic, they are hydrophilic polymers. Hydrocolloids are used in wide range as a coating froming solution to coat and control the colour, texture, flavor and shelf life of fruits and vegetables. Generally all hydrocolloids are partially or completely dissolve in water and principle use of this is to increase the viscosity of the aqueous phase. They act as an emulsifier due to their stablilizing effect.

1. Polysaccharides

- Polysaccharides are the most abundant natural polymers produced by plants and have been used for various purposes: wood for shelter and fire, fruits, vegetables and seeds for eating, curing different diseases, and fibers for making paper and clothing.
- They are present in all types of mammals, organisms and plants.
- These are generally extracted along with water and the natural polymers are separated by anion exchange chromatography.
- Polysaccharides are generally used as thickeners because of their viscosity increased when hydrated.
- They are also used to form edible films.
- Polysaccharides include cellulose derivatives, starch, chitosan, alginate, pectin, carrageenan etc.
- Since cellulose and chitin are water-insoluble in native stat, they are chemically treated first to increase the solubility.
- Alginate and pectin, on otherside, require calcium ions to be added so as to form gel.

1.1. Cellulose Derivatives

- Cellulose is the most abundant polysaccharide that contains repeating D-glucose units linked by ß-1, 4 glycosidic units.
- Cellulose is insoluble in water due to strong hydrogen bonding. Thus cellulose derivatives are derived to form edible films.
- When cellulose is treated with alkali followed by chemical reaction, it forms hydroxypropyl cellulose which is edible polymer.

1.2. Chitosan

- Chitin is the second most abundant polysaccharide (next to cellulose) found in exo-skeleton of invertebrates.
- Chitosan is derived from chitin.
- Chitosan is popular for its antifungal behavior.
- Chitosan based films are clear, tough and flexible.
- They show good resistance to oxygen, fat and oil, but they are highly sensitive to moisture.

1.3. Starch

- Starch is naturally produced polymer by plants such as potatoes, corn and rice.
- Starch contains two macromolecular elements: amylose and amylopectin, in which amylase is a linear polymer and amylopectin is branched polymer.
- Due to hydrophilic nature of starch, water is absorbed by starch granules and form gel on cooling.

1.4. Alginate

- Alginate is a salt of alginic acid derived from the cell walls of brown algae and seaweed.
- Alginate is capable of producing a strong gel or insoluble polymer when reacting with polyvalent metal cations (such as calcium).
- Calcium-alginate gel is used in restructured foods such as crabsticks, onion rings, meat products etc.

1.5. Pullulan

- Pullulan is a microbial polysaccharide, consisting of maltotriose units, synthesized from starch by *Aureobasidium pullulans*.
- Pullulan is highly water-soluble and is capable of forming edible films.
- These films are heat-sealable, odourless, colourless, tasteless, transparent, water permeable and low oil and oxygen permeable.

1.6. Gellan

- Gellan is a microbial polysaccharide produced by *Sphingomonas elodea* (a bacterium) and deacylated gellan is used in food industry as edible gel.
- Gellan based films are hard and brittle gels.

1.7. Carrageenan

- Carregeenan are sulphated polysaccharides derived from the cell walls of red sea weeds.
- It produces thermo reversible gels in an aquous solution.
- The use of carrageenan edible films found application in meat, poultry and fish for preventing superficial dehydration.

1.8. Pectin

- Pectin is a polysaccharide mostly extracted from citrus fruits.
- Pectin based edible films are brittle and addition of a plasticizer makes them flexible.
- It is used in the packing of fresh and minimally-processed fruits and vegetables.

1.9. Agar

- Agar exists in red algae as a gel at the natural environment.
- It is insoluble in cold water and is soluble in hot water.
- Agar is generally used as a gel inducer in candy and desserts.

2. Proteins

- Protein is a heteropolymer of more than a hundred amino acids linked by peptide bonds.
- The mechanical properties of protein films are better than that of polysaccharides due to its unique structure.
- Proteins exist in two forms: fibrous and globular
- Fibrous proteins (collagen and fish myofibrillar proteins) are generally water soluble, while globular proteins (soy protein, egg albumin and wheat gliadin) are water insoluble and should be denatured before the film formation.

2.1. Gelatin

- Collagen is the fibrous protein found in both vertebrates and invertebrates.
- Gelatin is produced by the process of hydrolysis of collagen.
- Gelatin based edible films have higher film thickness and increased mechanical properties but water vapor permeability decreases.

2.2. Soy protein

- Soy protein is extracted from soybeans.
- Soy protein is commercially available in three forms: soy flour, soy concentrate and soy isolate.
- Soy protein film is generally produced from soy protein isolates and is flexible, clear and smooth.

2.3. Corn zein

- Corn zein is a protein extracted from corn, which is insoluble in water.
- Cozeen, a commercial edible coating used for candy and nuts, contains corn zein as its major component.

2.4. Wheat gluten

- Wheat gluten is a water insoluble protein extracted from wheat flour.
- It contains gliadin and glutenin.
- Wheat gluten films could be made by thermoplastic processing, followed by, thermo-mechanical treatements.

2.5. Myofibrillar protein

- Fish is the typical source of myofibrillar proteins that could form the edible films.
- Edible films formed by myofibrillar proteins are flexible and semi-transparent.

2.6. Milk proteins

- Milk proteins are divided into casein proteins and whey proteins.
- Casein based films remain stable for a range of pH, salt concentration and temperature.
- Whey proteins are obtained after casein proteins are precipitated at pH 4.6.
- Whey protein isolate is the general form of whey protein used to form edible film.

Lipids

- Lipids can be derived from natural waxes (candelilla wax, carnauba wax, beeswax and rice bran wax), petroleum based waxes (paraffin and polyethylene wax), oils (paraffin oil, mineral oil, vegetable oil), acetoglycerides and oleic acids.
- Solid waxes are more resistant to water vapour and gas transfer as compared to oily waxes.
- Candelilla wax and carnauba wax are most common plant waxes used for making food coatings.
- Carnauba wax is made from the leaves of the Brazilian palm, namely, Copernica cerifera. It is commonly used lipids extending the shelf-life of fruits and preventing the moisture loss.
- Candelilla wax is obtained from candelilla plant.
- Beewax is produced from honeybees.
- Paraffin wax is derived from distillate fraction of crude petroleum and permitted for use on raw fruits and vegetables and cheese.
- Mineral oil consists of a mixture of liquid paraffin and naphtheric hydrocarbon.
- Waxes are used as barrier films to gas and moisture and to improve the surface appearance of various foods)