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ADVANCEMENT IN CONVENTIONAL PACKAGING – EDIBLE PACKAGING

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ABSTRACT

Edible packaging has come up as a breakthrough in the field of packaging by reducing waste, creating novel applications for improving food's stability, safety, quality and sensory aspects. Edible packaging offers upper hand over conventional packaging as it can be safely ingested along with the food. Gelatin, starch, whey protein isolates, soy protein, casein, etc. are various sources of edible packaging material. Edible packaging of fresh fruits and vegetables provides barrier to water loss and prevents microbial proliferation. In meat, edible packaging helps to preserve color and may prevent lipid oxidation in fishes. The role of edible packaging is imperative in today's environmental pollution. This paper reviews the history, requirements, advantages &disadvantages, applications, antimicrobial property of edible packaging, consumer acceptance, feasibility of commercialization, present status and future prospects of edible packaging.

KEYWORDS: edible packaging, antimicrobial activity, and moisture transfer.

INTRODUCTION

Packaging refers to enclosing materials in order to protect them from external damages thereby, hindering entry of extraneous materials including microbes. Some packaging materials possess the inherent capability of conserving the organoleptic properties of food and advancing overall food quality and consumer acceptance. Conventional packaging materials are made from diverse complex polymers that are not only difficult to synthesize but are also non-biodegradable. Moreover such packaging materials cannot be consumed but edible packaging as the name coined can be. Edible packaging is the new expanse for research in food and pharmaceutical industries. It is rapidly enhancing using edible components like proteins (e.g.casein, gelatin), polysaccharides (e.g.starch), lipids and /or resins, and other renewable edible compounds. Edible packaging usually occurs in the form of edible films, coatings, sheets and pouches. Edible films / sheets differs from edible coatings as the former is preformed separately from the food product and then placed on it whereas the latter are formed directly onto the surface of food product.[1]

History of edible packaging

For comfortable survival, human beings are functioning laboriously to bring advancements in conventional technologies. Humans have devised methods to protect food from dirt and damage [2] and enhance shelf life. Humans have progressed from using packaging of natural containers (made from tree trunks, rocks, gourds, shells, leaves and animal hides) to [3,4] edible packaging. Edible films dates back long time ago in food products.[5] In China, during twelfth and thirteenth century, citrus fruits were coated with wax to delay dehydration.[6] Application of fats to meat cuts to prevent shrinkage has been a usual practice since at least the sixteenth century.[7] Later in the last century, the preservation of meat and other foodstuffs by coating with gelatin film was suggested.[8] Since, 1930sthe emulsion made of waxes and oil in water were spread on fruits to improve their appearance, like shininess, color, softening, onset of mealiness, carriage of fungicides and to control their ripening in a better way and to retard the water loss.[5]

Requirements for the use of edible packaging

Codex Alimentarius illustrates food as, all raw, partially treated or treated substances used for human nutrition and feeding including drinks, chewing gum and all components use in the formulation, preparation, making or treatment of foods. Although edible packaging in itself does not provide significant amount of nutrients thus, it is more appropriate to describe it as additive.. On the other hand, nutritional quality can also be improved by edible packaging's, and thus, it also qualifies as a food ingredient.[5] It is essential for edible packaging material to be tasteless so that the taste of food is unaltered[9] or else it should be compatible with that of food.[10] The use of edible packaging mandatory requires an over packing, for convenient handling and hygienic reasons.[5] Edible packaging is considered essential for maintaining the quality, stability of some fresh, treated or frozen food products.[9-11] Additional fundamental requirements for the use of edible packaging are listed in Figure 1.[12,13]

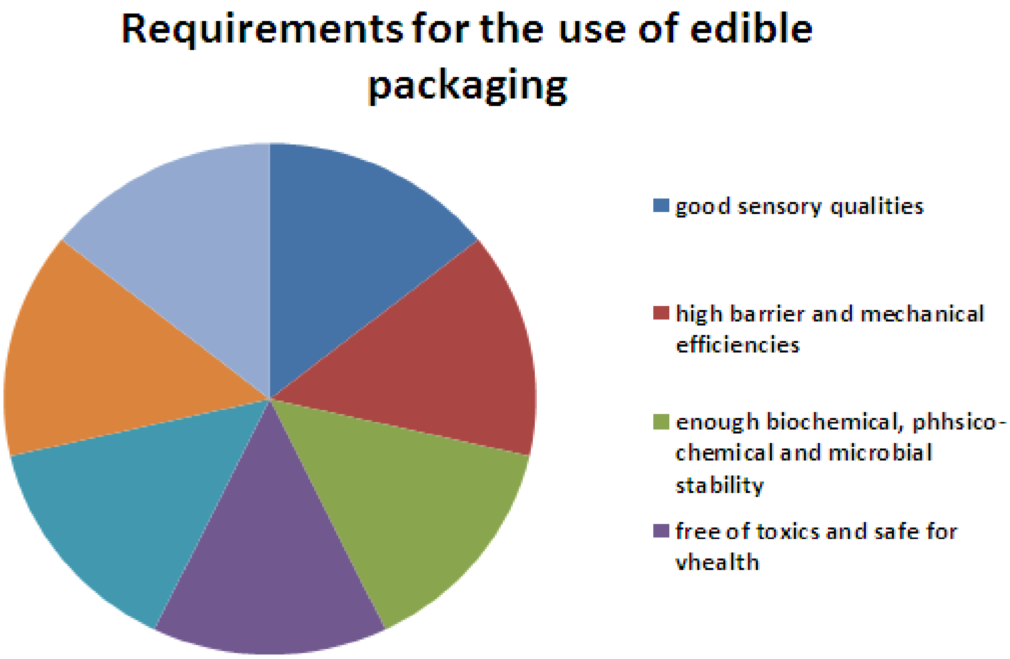

Fig 1. Requirements for the use of edible packaging.

Advantages of edible packaging

- Edible packaging is not only biodegradables but also eco-friendly.[8]
- Edible packaging like conventional non-biodegradable packaging provides semi-permeable barrier to water vapor, oxygen and carbon dioxide between the food and the surrounding atmosphere.[14]
- Additional functionality can be imparted in edible packaging by incorporating antioxidant, flavoring agents, growth regulators, antimicrobials etc.[15, 16]
- Coating of edible packaging reduces weight loss and early senescence in fresh fruits and vegetables.[17, 18]
- Edible coatings can also be used to provide gloss to the product.
- Edible coatings are non – toxic and pose no health hazard due to polymer leaching unlike conventional polymer based packaging.
- The films can be used for individual packaging of small portions of food particularly that of pears, beans, nuts and strawberries that are currently not packaged like this.[6]

- Edible films can be modified to prevent deteriorative transfer of inter-component moisture and solutes in foods such as pizzas, pies and candies and, simultaneously can be used to check diffusion rate of preservative substances from the surface to the interior of foods.[8]
- Overall, edible packaging has good process ability and is heat sealable.[5]

Disadvantages of edible packaging

- Mechanical properties are inferior in comparison to plastics.
- Edible films and coatings require an additional packaging of paper or plastic because of sanitary purposes.
- Most of the hydrocolloids from which edible films are formed gets wholly or partially solubilized in water thus it restricts there use in low water activity food products.

PERFORMANCE AND EVALUATION METHODS

Appropriateness of edible films typically depends on their mechanical and barrier properties. Characterization of edible films is can be done based on various parameters. Thickness of films can be measured using screw gauge. Film densities can be determined from film weight and volume. The next characterization parameter is whiteness index, yellowness index, total color difference which can be estimated using colorimeter. Opacity and light transmittance can be estimated using spectrophotometer. They can also be measured using opacity meter. Water vapor permeability is defined as the rate of water vapor transmission per unit area of flat material of unit thickness induced and per unit vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions.[5] WVP can be estimated using "cup method" based on the gravimetric technique.[19-22] Apart from WVP, water vapor resistance (WVR) can also be estimated by methods based on modification of Fick's equation.[23] Oxygen and carbon dioxide permeability can be measured using similar method. For fruits and vegetables the study of permanent gas permeability is significant, particularly for oxygen and carbon dioxide.[5] Rheological parameters of edible packaging are equally important. It is essential for edible packaging to project good mechanical properties. Mechanical properties can be determined by tensile tests including tensile strength, elongation at break and elastic modulus. Elongation at break is measure of the extent a substrate will stretch before it breaks. Tensile strength of material is maximum amount of force required to the point where it breaks. Universal testing machine is most commonly used for determination of tensile strength. Puncture test is carried out to estimate impact resistance of package. In case of antimicrobial edible films, microbial barrier is measured which is based on log reduction value. Depending upon functionality introduced, particular assays can be carried to evaluate the efficacy of introduced functionality.

RECENT ADVANCES AND APPLICATION OF EDIBLE PACKAGING

Edible packaging is a very new concept in comparison to packaging from synthetic plastics, but the advances are multifarious. The biggest advantage of such films and coatingsis that it can be consumed with the food and thus reduces load on Mother Nature. Edible packaging has mainly been synthesized from polysaccharides and protein. Researchers are working on various edible film and coatings with optimum mechanical and physio-chemical properties like oxygen, carbon dioxide and water permeability.[24] The most common polymers used in formulation of edible films are proteins (gelatin, casein, wheat gluten), polysachharides (starch, chitosan) and lipids. (Table 1)

Types of edible packaging	Composition	Application	References
Polysaccharide	Amylose rich tamarind seed starch, spice, glycerol and xanthan gum	Meat Packaging	[25]
	Tapioca starch,Natamycin, nisin, glycerol	Port salut cheese packaging	[26]
	Native corn starch (AMISOL® 3408), native waxy corn starch (AMISOL® 4000, around 100% amylopectin) and modified waxy corn starch (FLUIDEX® SS-22)	Red crimson grapes packaging	[27]
	Starch (potato and cassava), chitosan, glucose and glycerol	Food packaging	[28]
	Lemon essential oils and chitosan	Food packaging	[29]
	Sodium alginate and pectin with citral and eugenol	Strawberries packaging	[30]
	arboxymethyl cellulose (CMC), hydroxypropylmethyl cellulose (HPMC) and composites with chitosan (CH)	Strawberriespackaging	[31]
	Chitosan and beewax	Strawberriespackaging	[32]
	Chitosan, lemon essential oil	Strawberrypackaging	[33]
	carboxymethyl cellulose (CMC) and chitosan	Citrus fruitpackaging	[34]
	lemongrass essential oil incorporated into an alginate-based [sodium alginate 1.29% (w/v), glycerol 1.16% (w/v) and sunflower oil 0.025% (w/v)]	Fresh-cut pineapplepackaging	[35]

	Galactomannans, glycerol	Tropical fruits: acerola (*Malpighia emarginata*), cajá (*Spondias lutea*), mango (*Mangifera indica*), pitanga (*Eugenia uniflora*) and seriguela (*Spondias purpurea*	[36]
	polysaccharide from *Anacardium occidentale* L. (Policaju) and a surfactant (Tween 80)	Applespackaging	[37]
Protein	Whey protein isolate, almond oil/walnut oil	Edible food coatings	[38]
	Whey protein concenterate, trehalose and glycerol	See -through packaging	[39]
	Soy protein isolate and cysteine	Fresh cut eggplant	[40]
	Whey protein isolate, oregano, garlic, rosemary and essential oil	Antimicrobial food packaging	[41]
	Whey protein isolate, p-aminobenzoic acid, sorbic acid	Antimicrobial food packaging	[42]
	Shrimp muscle protein and glycerol	Food packaging	[43]
	Soy protein isolate and ferulic acid	Fresh lardpackaging	[44]
	Pea protein and glycerol	Food packaging	[45]

Proteins or starches alone produce fragile films with inferior mechanical properties. Plasticizer like glycerol (most commonly used) decrease intermolecular forces along polymer chain thereby giving the required flexibility, elasticity and extensibility.[39]

In recent years, researchers have been focusing on biodegradable films, which could multifunction. Edible films are being synthesized in a fashion so that they can also be used as a carrier of active compounds like antioxidants, flavorings, antibrowning and antimicrobial.[46] Various spices & essential oil [25, 29, 30, 33, 41] have been incorporated in edible films to enhance antimicrobial efficacy and prolong shelf life of food. Spices and essential oils can be incorporated in edible packaging by encapsulating in the form of nanoemulsions.[47]

The typeof edible packaging required for a particular food productdepends on the specific characteristics of the food product and the intended storageconditions. Edible films and coatings have been applied on meat, poultry, seafood, fruits and vegetables, grains, candies, heterogeneous and processed foods (Table 1).

FUTURE SCOPE OF EDBLE PACKAGING

Edible films and coating should not only play the role of packaging material but should also be safe since they are to be consumed by consumer with the food packed. The components used in the synthesis of edible packaging to should be safe or must have GRAS status or sanctioned by the United States Food and Drug Administration (FDA) Code of Federal Regulations or the U.S.Pharmacopoeia / National Formulatary. A food manufacturer should clearly declare al the components of edible packaging system including common allergens so as to provide information to consumers having any sort of allergies or intolerances towards particular food components. This regulation comes under Food Allergen labeling and Consumer Protection Act of 2004.

Edible films have coatings have gained popularity and a lot of research is being carried out in the field. A lot of work has been carried out at pilot level but commercialization is still a far fetched dream. Edible packaging offers a lot of advantages over traditional synthetic polymers. Researches are trying to advance edible packaging for enhancing shelf life, retarding deterioration and keeping safety of food packed.[48] Edible packaging though, cannot be used for long-term storage since they are biodegradable.[49] Thus, to enable edible packaging to work upfront with traditional packaging system, durability for longer periods is the need. Another hurdle in the large-scale usage of edible packaging is cost of manufacturing. In today's scenario it is quite difficult to deliver edible packaging at the price of traditional packaging. To cease down te cost researchers are targeting waste by products of food industry in the synthesis of edible films and coatings thereby solving the dual problem of cost and global pollution.

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