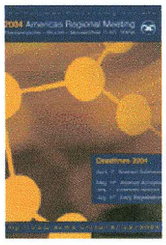

# EDIBLE FILMS MADE FROM PROTEIN AND POLYESTER

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This work relates the barrier properties [water vapor permeability (WVP)] and mechanical properties (tensile strength and elongation) of edible films made of proteins and polyester with different proportions of plasticizer. Gelatin and poly (hydroxybutyrate)-(PHB) produce transparent and flexible edible films or coatings with reduced water absorption and high mechanical properties. When increasing polyethylene glycol amount, a decrease of tensile strength was observed.

## Introduction

The "isopor", corporate name of expanded polystyrene, is a synthetic polymer that comes from petrolium, a not-renewable resource. This polymer is often used to produce packagings and has the disadvantage of not being biodegradable, therefore it can lead up to 150 years to putrefy itself. It leads to an irreversible buildup of municipal solid waste causing fouling of beaches, scarring of landscapes, and several problems to marine life[1].

One of the current concerns with the environment is the acumulated packaging of plastics, not degradable. It creates a great expectation for more ecological and economically viable alternative to minimize the environmental impact.

Several materials from agricultural resources have been used to produce renewable biodegradable, and edible packaging, frequently called agricultural or agropackaging materials, as protein and polyester [2].

Since the important works of Bradbury and Martin [3] on the gelatin for packaging, coating, and film fabrication, a great deal of work has been accomplished in this field [2,4]. The proteins (egg albumin, keratin, casein, gelatin, and others) offer better mechanical properties including barrier, than polysaccharides. The protein films are usually transparent, flexible, water-resistant, and impermeable to oxygen [3,4]. The biodegradable protein and polyester films with satisfatory mechanical properties and good appearance, exemples of bioplastic are a potencial ecological alternative to substitute sinthetic polymers.

The aim of this study was to manufacture edible films based on proteins and polyester with different proportions of plasticizer (polyethylene glycol-300 - PEG), in order to determine the mechanical properties and barrier of these films.

## Experimental

*Materials and methods* - The following materials were used to prepare film: animal gelatin (via farma); poly (hydroxybutyrate)-(PHB) (usina da pedra); polyethylene glycol-300 (sigma chemical), chloroform (synth) and distilled water.

*Preparation of protein films* – Gelatin was suspended in water at 50°C after stirring for 30 minutes, and the plasticizer was added (PEG-300 – 2.0, 10.0 and 20.0g/100g of protein). Cast films were prepared by slow evaporation of the water.

*Preparation of polyester films* - Polyester films were prepared using a casting process. The filmogenic solutions were prepared by dissolving PHB (3.0 g of PHB / 125 mL of chloroform) and PEG in chloroform. The solution was heated to 70°C to dry and a transparent film was formed.

*Mechanical properties* - Tensile strength was measured using an Instron Universal Testing Instrument (model 4400R) operated according to ASTM D 412 – 80 [5] with a crosshead speed of 50mm/min. Five specimens of 4.0 cm x 2.70 cm were cut from each film.

*Water vapor transmission (WVT)* was determined according to ASTM E96-80 [6], modified by Gontard et al. [7]. A container with silica gel was closed with a sample of edible film firmly fixed on top. Then, the container was placed in a desiccator with distilled

water at a temperature of 25.0 °C. The films were weighed daily on a Mettler analytical balance for 10 days. The water vapor transmission (WVT) was calculated according to equation 1:

$$WVT = \frac{w \times x}{A} \qquad (1)$$

*where* WVT *is Water Vapor Transmission (g* $H_2O$*. mm.cm*$^{-2}$*),* x *is the average thickness of the film (0.048* $\pm$ *0.012 mm) and* A *is the permeation area (12.57 cm*$^2$*).*

**Results and Discussion**

Emulsions of gelatin or poly (hydroxybutyrate) – PHB - dispersed in aqueous solution - produce transparent and flexible edible films or coatings with reduced water absorption and high mechanical properties. When increasing polyethylene glycol amount, a decrease of tensile strength was observed. The results of tensile strength and elongation in the rupture and water sensitivity of gelatin and PHB are given in table 1.

**Table 1** – Tensile strength, percentage elongation and water sensitivity of gelatin and PHB edible films.

| Film | PEG (%) | Tensile strength (MPa) | Elongation (%) | Water sensivity (%) |
|---|---|---|---|---|
| Gelatin | 2 | 330.35±66.07 | 47.24±9.44 | 100 |
| | 10 | 310.00±46.21 | 155.00±10.20 | 100 |
| | 20 | 208.35±41.67 | 189.43±47.35 | 100 |
| PHB | 2 | 26.26±8.75 | 25.05±6.26 | 2.00 |
| | 10 | 12.71±3.17 | 25.35±8.45 | 7.30 |
| | 20 | 32.66±8.16 | 31.89±7.97 | 22.0 |
| PVC | 0 | 19.46±1.07 | 170.00±24.00 | 0.72 |

The mechanical properties of proteins and polyester films are influenced by the plasticizer concentration. The protein films, elaborated with 2% of PEG, presented the greatest value of tension in the rupture and low elongation which characterize a more rigid and fragile material. The protein films and polyester with plasticizer content above 2% are more elastic, presents less tension in the rupture and more elongation. Park *et al.* [8] reported that mechanical properties decreased as the concentration of glycerin increase in edible films made of proteins and celluloses.

Effects of plasticizers on barrier properties of films were compared (fig.1). WVP of gelatin films are greater than those of PHB and vinyl polycloride (PVC) films. WVP of films studied which contained PEG increased as concentration of PEG increased. Park et al. [8] also reported that plasticizers enhanced or retarded WVP of cellulose-based films, depending on their concentrations.

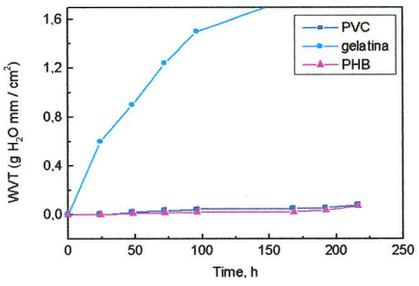


**Figure 1** – Plasticizer effect on barrier properties of gelatin, PHB and PVC films. WVP = water vapor permeability.

**Conclusion**

Edible films of proteins produced by "casting" are sufficiently transparent, with good mechanical properties, with potential application for dry food packaging. Edible films of polyester have similar mechanical characteristics as the synthetic films used in supermarkets (vinyl polycloride (PVC)). The mechanical properties of proteins and polyester films are influenced by the plasticizer concentration. An increase in PEG content showed a considerable increase in elongation percentage and a decrease in the tensile strength of the films, also increases the permeability and the solubility of the films in water owing to the hydrophylic nature.

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