EDIBLE FILMS OF POLYESTER AND TALC: BARRIER PROPERTIES TO WATER VAPOUR TRANSMISSION

Patrícia Ponce[1*], Laura G.Carr[2], Duclerc F. Parra[3], Ademar B. Lugão[4]

[1]Instituto de Pesquisas Energéticas e Nucleares (IPEN/CNEN), PO Box 11049, 05422-970, São Paulo, SP, Brazil - patponce@iq.usp.br; [2]Instituto de Pesquisas Energéticas e Nucleares (IPEN/CNEN) – laura.carr@poli.usp.br; [3]Instituto de Pesquisas Energéticas e Nucleares (IPEN/CNEN) – duclercp@iq.usp.br; [4]Instituto de Pesquisas Energéticas e Nucleares (IPEN/CNEN) – ablugao@ipen.br.*

This work reports the barrier properties [water vapor permeability (WVP)] and mechanical properties (tensile strength and elongation) of edible films made of polyester with different proportions of talc. The mechanical properties of films are influenced by the talc concentration. When increasing talc amount, a decrease of water vapour permeability 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 polyester film with satisfatory mechanical properties and good appearance, exemple of bioplastic is a potencial ecological alternative to substitute sinthetic polymers.

The aim of this study was to manufacture edible films based polyester (**PO**) with different proportions of talc (**T**), in order to determine the mechanical properties and barrier of these films.

Experimental

Materials and methods - The following materials were used to prepare film: biodegradable aliphatic-aromatic copolyester (**PO**, Basf); talc (**T**, Synth), chloroform (Synth) and distilled water.

Preparation of polyester films - Polyester films were prepared using a casting process. The filmogenic solutions were prepared by dissolving polyester (60 g of **PO** / 125 mL of chloroform) and talc (**T**, PO:T weight ratio of 1:1, 1:2 and 1:4) 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 dessiccator 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 (0.050 0.012 mm) and* A *is the permeation area (12.57 cm*^{2}*).*

Results and Discussion

The results of tensile strength and elongation in the rupture and water vapor transmission rate (WVTR) of polyester and polyester + talc are given in table 1.

Table 1 – Tensile strength (TS), percentage elongation and water vapour transmission rate (WVTR) of polyester and polyester + talc edible films.

Film	Tensile strength at maximum (MPa)	Elongation at break (%)	WVTR ($gH_2O.mm.h^{-1}.cm^{-2}$)
Polyester	12,16 1,91	778,57 240,07	7,77
Polyester + talc, 1:1	25,04 3.17	678,54 160,07	5,18
Polyester + talc, 1:2	36,12 2.34	656,87 110,09	6,77
Polyester + talc, 1:4	70,20 3.97	532,67 135,23	1,04

The mechanical properties of polyester films are influenced by the talc concentration. TS of films increased as concentration of talc increased. TS of **PO-T** films are greater than those of **PO** films.

The results of water vapour transmission (WVT) on the **PO** and **PO-T** are shown on the fig.1. As expected, the talc addition considerably reduced the WVT. WVT of polyester films, at 25^0C, varied linearly with the talc concentration, with very good correlation coefficient (R^2= 0.98).

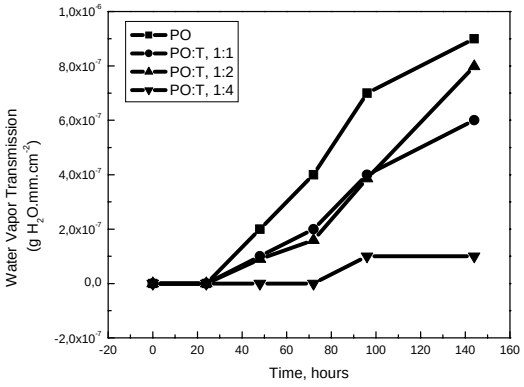

Figura 1 – Barrier properties of polyester (**PO**) and polyester + talc (**PO-T**, **PO:T** weight ratio of 1:1, 1:2 and 1:4) films. WVP = water vapour permeability.

Conclusions

Edible films of polyester produced by casting process are transparent enough, with good mechanical properties, with potential application for food packaging. Edible films of polyester have similar mechanical characteristics as the synthetic films used in supermarkets (poly vinylcloride (PVC)). The mechanical properties of polyester films are influenced by the talc concentration. An increase in talc content showed a considerable increase in the maximun tensile strength and a decrease in the elongation percentage of the films. The edible film with talc was an efficacious barrier to the transport of water vapour. WVTR can be significantly reduced by adding the talc.

Aknowledgements

To FAPESP (The State of São Paulo Research Foundation) and CNPq (National Council for Scientific and Technological Development) for the financial support.

References

1. P.L.Nayak, J.M.S.-Rev. Macromol. *Chem Phy*., 1999, *39*, 481;
2. B.Cuq; N.Gontard; S.Guilbert *Cereal Chem*., 1998, *75*, 1;
3. E.Bradbury; C.Martin *Proc.R.Soc*., 1952, *214*, 183;
4. H.M.C.Azeredo; J.A.F.Faria; A.M.C.Azeredo *Ciênc. e Tecnol. de Aliment*., 2000, *20*, 337;
5. ASTM D412-98a. Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension. Annual book of ASTM standards. Designation D412-98a (pp 43-55). Philadelphia:ASTM;
6. ASTM Standard (1989). Standard test methods for water vapor transmission of materials. Annual book of ASTM standards. Designation E96-E80 (pp.730-739). Philadelphia: ASTM;
7. N.Gontard; S.Guilbert; J.-L. Cuq *J. Food Sci*., 1993, *58*, 206;
8. H.J. Park; C.L.Weller; P.J.Vergano; R.F.Testin *J. Food Sci*., 1993, *58*, 1361.