NANOCOMPOSITES OF POLYVYNIL ALCOHOL AND BANANA FIBRE NANOCELLULOSE

André Luís Sousa Pereira[1], Judith Pessoa de Andrade Feitosa[2], Men de sá Moreira de Souza Filho[3(*)], Ana Ribeiro Cassales[4], João Paulo Saraiva Morais[5], Ana Iraidy Santa Brigida[6], Morsyleide de Freitas Rosa[7]
[1,2]Department of Organic and Inorganic Chemistry, Federal University of Ceará, Fortaleza, Brazil
[3,4,7]Embrapa Tropical Agroindustry, Fortaleza, Brazil
[5]Embrapa Cotton, Campina Grande, Brazil
[6]Embrapa Food Technology, Rio de Janeiro, Brazil
[(*)]*Email:* **men.souza@embrapa.br**

ABSTRACT

This work compares some mechanical properties of PVA and banana fibre nanocellulose composites, as well as the neat polymer film. Three nanocellulose concentrations (1%, 3%, and 5% w/w) where added to the films and the tensile strength, elongation at break, and Young´s modulus were measured, as well as water vapour permeability. The addition of small concentration of nanocellulose improved the mechanical properties of PVA film, what may be used for development of further biobased products.

INTRODUCTION

Several environmental problems are caused by oil-based polymers. In this context, the use of biobased films may help to reduce the impact due to the biodegradability (Henrique, 2007). Polyvynil alcohol (PVA) is a water-soluble and biodegradable polymer, which may be reinforced with polar fillers, as nanocellulose whiskers to improve mechanical properties as Young´s modulus (Roohani, 2008).

A mechanical assay with a neat PVA film and nanocomposites of PVA and 3 contents of banana pseudostem fibre nanocellulose were carried out. The PVA was kindly given by Clariant, with a molar mass of 205 kg mol^{-1} and 87.7% hydrolysis degree. The nanocellulose was produced by acidic hydrolysis as described by Orts (2005) with slight modifications. The PVA solutions were prepared so that their concentrations were 6% (w/w). The nanocomposites were prepared with addition of banana nanocellulose in several contents: 1% w/w (PVA1), 3% w/w (PVA3), and 5% w/w (PVA5). The PVA solution without filler was named PVA0. The mixtures were casted on a glass plate (30 cm x 30 cm) and adjusted to 1 mm thick. The films were let to dry for 24 hours at 25 ºC and relative humidity of 74%. The films were cut in the template for the mechanical assays to calculate tensile strength, elongation at break, and Young´s modulus at 26 ºC and relative humidity of 55%, following the standard test method ASTM D 882-00. The water vapor permeability (WVP) determination was based on the method E96-80.

RESULTS AND CONCLUSIONS

The results from the mechanical tests and water vapour permeability are shown in table 1. Addition of nanocellulose in small amounts reinforced the PVA films in a way that the mechanical parameters were increased. The PVA1 showed the higher tensile strength, with the mean almost twice greater than PV0, as well as the higher elongation at break. The PVA3

showed the higher average Young´s modulus. However, the greater nanocellulose concentration presented values very close to PVA0 for almost all parameters. This might be an evidence of an agglomeration of nanowhiskers.

The water vapour permeability decreased as a function of the increase of the nanocellulose concentration. This may be due to physical barrier property of the nanowhiskers in the nanocomposite structure.

The nanocellulose filler has hydroxyls that interact with the hydroxyls of the PVA. In general lines, the addition of cellulose nanowhiskers improved the material properties. Further tests will be performed in order to check other characteristics, as colour.

Table 1 Mechanical and barrier properties for PVA film and PVA-nanocellulose composites

	Tensile Strength (Mpa)	**Elongation at Break (%)**	**Young´s Modulus (MPa)**	**WVP ($g.mm/kPa.h.m^2$)**
PVA0	13.9±8.8	61.0±19.3	2522±437	0.61±0.04
PVA1	26.0±8.7	96.1±7.6	2570±146	0.56±0.03
PVA3	14.1±6.1	74.3±17.2	2940±218	0.51±0.03
PVA5	14.1±7.5	83.0±12.5	2586±74	0.44±0.01

ACKNOWLEDGMENTS

The authors gratefully acknowledge CNPq, and Capes for funding the research. and Clariant for PVA donation.

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