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Water Vapor Permeability of Alginate-Acerola Puree Edible Films as Affected by Cellulose Whiskers

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Abstract – The objective of this study was to evaluate the influence of cellulose whiskers (CW) from different types (i.e., from cotton fiber or from coconut husk fiber submitted to different bleaching levels) on water vapor permeability (WVP) of edible films made from sodium alginate and acerola puree. Significant reductions of WVP were observed with increasing CW concentrations. CW from coconut husk fiber (even if submitted to a single bleaching stage) is equivalent to CW from cotton fiber in reducing WVP of the films.

Cellulose whiskers (CW) were extracted from (a) cotton fibers, or (b) coconut husk fibers submitted to one-stage or (c) multi-stage bleaching. Since coconut fibers are rich in lignin, which makes fiber separation and CW extraction difficult, delignification by bleaching is needed [2]. Bleaching was carried out according to Wise et al. [3]; one- and multi-stage bleaching were defined by Rosa et al. [2].

Nine nanocomposite films were produced by using three concentrations (5, 10, and 15%, on a dry basis) of each of the three types of CW. Moreover, a control film (without CW) was elaborated. 1.6 g of sodium alginate were diluted in 50 mL of distilled water in a magnetic stirrer (60 min, 200 rpm, 50°C). 100 g of acerola puree, 4 g of corn syrup (plasticizer), and cellulose whiskers were then added, and the mixture was homogeneized in a magnetic stirrer and in a sonicator. The mixture was vacuum degassed, cast on glass plates and leveled with a draw-down bar to a thickness of 1.2 mm. The films were placed on a lab bench (24°C ± 1°C) for 24 h to dry. Then, samples were cut and detached from the surface for water vapor permeability (WVP) determination, according to the method E96-80 [1].

Table 1 indicates that WVP was not significantly affected by the type of CW, that is to say, CW from coconut husk fiber (even if submitted to a single bleaching stage) presented similar performance to CW from cotton fiber in terms of reducing WVP of alginate-acerola films. On the other hand, the effect of the CW concentration was significant. Indeed, Tukey test (Table 2) indicates that increasing the concentration of any CW type resulted in significant WVP reduction.

Table 1. Anova of WVP of alginate-acerola films.

Source of variation	DF	SS	MS	F	p
Type of CW	2	0.10	0.05	2.61	0.08
CW concentration	3	3.81	1.27	65.49	< 0.01
Interaction	6	0.06	0.01	0.55	0.77
Error	84	1.63	0.02		
Total	95	5.60			

DF: degrees of freedom; SS: sum of squares; MS: medium square.

Table 2. WVP (g.mm/kPa.h.m^2) of alginate-acerola films, at 24ºC/75% RH (medium ± standard deviation).

CW (%)	CW types		
	Coconut (multi-stage bleaching)	Coconut (one-stage bleaching)	Cotton
0	(1.15 ±0. 17) a	(1.15 ± 0. 17) a	(1.15 ± 0. 17) a
5	(0.87 ± 014) b	(0.77 ± 0.14) b	(0.90 ± 0.17) b
10	(0.79 ± 0.12) bc	(0.75 ± 0.08) b	(0.82 ± 0.11) bc
15	(0.66 ± 0.11) c	(0.53 ± 0.06) c	(0.60 ± 0.15) c

Values at the same column followed by the same letter are not significantly different (Tukey, p<0.05).

[1] ASTM. E96-80. In: Annual Book of American Standard Testing Methods. Philadelphia: ASTM, 1989. p. 730-739.

[2] M.F. Rosa, E.S. Medeiros, J.A. Malmonge, K.S. Gregorski, D.F. Wood, L.H.C. Mattoso, G. Glenn, W.J. Orts, and S.H. Imam. Carbohydr. Pol. (2010), *in press.*

[3] L.E. Wise, M. Murphy, A.A. D'Addieco, Paper Trade J. 122 (1946) 35-43.