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THE UTILIZATION OF TAMARILLO PEELS AS MATRIX OF BACTERIAL CELLULOSE-BASED NANOPAPER

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ABSTRACT

Bacterial cellulose (BC) pellicles and tamarillo peels (TP) organic waste have been utilized as basic component of nanopaper. BC pellicles and tamarillo peels were disintegrated by mechanical methods using home blender and mixed by dry weight based in various concentrations. The content of cellulose in the BC was 1.08% which consist of nanofibres cellulose. Physical properties of nanopaper (50BC:50TP) with 3.44% water content has been improved significantly compared to micropaper (0BC: 100TP) which the value of Young's modulus of 2.1 GPa by using quasistatic tensile strength test. Thermal degradation of nanopaper (50BC:50TP) described that the thermal resistance curve of nanopaper was between BC and tamarillo peels which has recorded by Thermogravimetry analysis (TGA) with 1.40 mg of mass residue.

Keywords: *Bacterial Cellulose, Tamarillo peels, thermal properties, mechanical properties, nanopaper*

INTRODUCTION

Tree tomato or tamarillo is a small tree native to the Andean region of Bolivia (Bohs, 1991; Bohs and Nelson, 1997; Lester and Hawkes, 2001). It is cultivated in for its fleshy edible fruits, which can be consumed raw, mostly for preparing juices, processed, or cooked (Bohs 1989a; Prohens and Nuez 2000). Studies on the chemical composition of tamarillo fruits are limited. The fruit is typically acidic and recommended for its nutritional qualities as a good source of provitamin A, vitamins C, B6 and E, and iron (Wills et al. 1986; Popenoe et al. 1989;Romero-Rodriguez et al. 1994; Vera de Rosso and Mercadante 2007). Tamarillo fruit is a good source of potassium. The peel of tamarillo is the main source of phenolic compounds and the part that showed the highest antiradical efficacy in this study, but the level of efficacy was rather low. (Vasco et al., 2009).Tamarillo peels has become wasted material because of its culinary demands.

Bionanomaterial like nanocellulose, nanochitin, and nanostarch has a potential to an important material. Nanocellulose has been intensively studied in medicine, biomaterial technique, membrane, magnetic material, electronic devices, and nanocomposite polymers (Gatenholm and Klemm, 2010; Siro and Plackett, 2010; Lavoine et al., 2012; Eichhorn et al., 2010; Ummartyotin et al., 2012). The main advantage of nanocellulose is it's biodegradability and is renewable resources, has specific strength, and high rigidity index, and has a high potential to become reinforcing agent, and also has high specific area (Siro and Plackett, 2010; Klemm et al., 2011).

Bacterial Cellulose (BC) is bionanomaterial which produced by *Acetobacter xylinum* in static culture media. BC fibres has high crystalinity degree, has fibre length around 30 nm, and have many advantages compared to another cellulose. BC has higher purity than another plant cellulose. (Fontan et al., 1990).

Nanopaper has been defined as layer that consist of purely nanocellulose and most of its physical and mechanical properties characteristics superior that normal paper (Henriksson et al., 2008; Sehaqui et al., 2011; Yousefi et al., 2011a). Based on its physical properties and its biodegradability, nanopaper can be classified as multiperformance material (Yousefi et al., 2012).

In order to utilize the waste of tamarillo peels, Tamarillo peels was been used to produce nanopaper by disintegrated it by home blender and mixed it with bacterial cellulose with dry-weight based, and mold it with hotpress. After that, it has been characterized by TGA and quasistatic tensile test to see it's mechanical and physical properties

METHODOLOGY

Materials. Collected tamarillo peels was processed in home blender for 10 min. The pulp of tamarillo peels was first washed in distillate water, then in 2.5% v/v NaOH and finaly in 2.5% w/v NaOH. The resulting pulp was then dried in vacuum oven at 100^oC, A strain of Acetobacter xylinum was inoculated into culture medium. The medium was prepared by dissolving 50 g glucose, 5 g yeast extract, 5 g $(NH_4)_2SO_4$, 3 g KH_2PO_4 and $MgSO_4.7\ H_2O$ in litre of still water. The pH is adjusted to 5.0 by using glacial acetic acid. The pellicles were obtained after 14 days. They were purified to remove bacteria cels as is usual when working with BC (Yamanaka et al., 1989; Roman et al., 2004), by washing them first in running tap water, then in 2.5% w/v NaOH and finally in 2.5% v/v NaOCl. The BC pellicles were then disintegrated using home blender for 3 min and dried in vacuum oven at 100^oC.

On a dry weight basis BC was mixed 100:0, 75:25, 50:50, 25:75, 0:100 with TP by mechanical method. The wet mixture was filtered and placed in laboratory press and compressed between fine wire meshes (#200) for 15 min at 115^oC. The 50:50 samples were used for TGA and tensile testing.

Characterization Tecniques. *Thermal analysis.* Thermogravimetry (TGA) experiments were carried in a Perkin Elmer Pyris TGA7. Scan rates of 20^oC/min in the temperature range 20 to 600^oC.The specimens were tested under a nitrogen atmosphere.

Quasistatic Tensile testing. Rectangular strips (50 mm x 5 mm) were cut from the films and tested in an Instron Gotech A1-7000M machine with 2000 kgf weight in standard laboratory conditions (30^{o}C). A crosshead speed of 1mm/min was used.

RESULT AND DISCUSSION

Thermal Analysis. Fig. 1 shows the relative weight loss for disintegrated BC, disintegrated tamarillo peels, and BC-Tamarillo peels nanopaper. The thermal degradation of BC, Tamarillo peels, and their nanopaper shows a similar degradation properties, the moisture release and degradation of proteinaceous matter occurs from 50^{o}C until 300^{o}C.

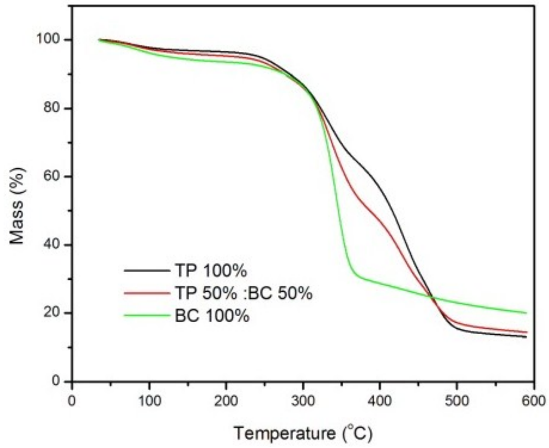

Fig. 1. TGA curves for disintegrated BC, Tamarillo peels, and BC-TP nanopaper.

Quasistatic Tensile Testing. The result of tensile test of the nanopapers shown in Fig.2, and 100% BC has the strongest tensile strength, and followed by 50BC:50TP nanopapers, and the weakest tensile strength goes to TP based from the curve. It is caused by huge differences of fibres diameter between BC and TP. However, from the result shows in Table 1, we can also see the significance of BC role in nanopapers, cause it can increase mechanical strength of TP dramatically.

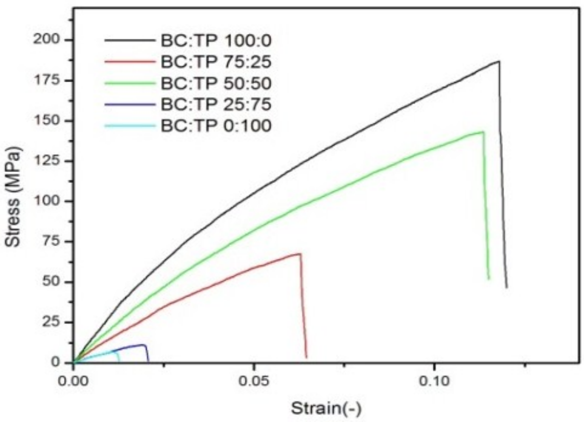

Fig. 2. Stress-strain curve of BC and TP (100:0; 75:25; 50:50; 25:75; 0:100)

Table 1. Young's modulus of nanopapers

No	Nanopapers Composition	Young's modulus
1	100 BC : 0 TP	3.3 GPa
2	75 BC : 25 TP	1.5 GPa
3	50 BC : 50 TP	2.1 GPa
4	25 BC : 75 TP	700 MPa
5	0 BC : 100 TP	500 MPa

CONCLUSION

From the result of this research, nanopapers can be produced by BC and TP, which shows a great improvement of mechanical strength from tamarillo peels, from 500 MPa to 2.1 GPa, and thermal degradation test of nanopapers (50BC:50TP) was between pure BC and pure TP papers.

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