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Short Communication

Water absorption and maintenance of nanofiber cellulose production by *Gluconacetobacter rhaeticus* TL-2C

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Physiochemical properties of bacterial cellulose producing by *Gluconacetobacter rhaeticus* TL-2C was investigated for confirming its possibility as wound care dressing material. Scanning electron micrograph showed that the diameter of bacterial cellulose fiber was 40 to 50 nm. Solid state ^{13}C nuclear magnetic resonance (NMR) data showed that the bacterial cellulose had amorphous peak of C-4 and C-6 and the crystallinity index of bacterial cellulose was 75.4. Water absorption ability of bacterial cellulose was 19-fold higher than α-cellulose. Bacterial cellulose had 2-fold higher water maintenance ability than α-cellulose.

Key words: Bacterial cellulose, *Gluconacetobacter rhaeticus*, nanofiber, water absorption.

INTRODUCTION

Bacterial cellulose is the major component of a pellicle on the top of growth media during inoculation on standing culture. Bacterial cellulose acts as a floatation device supplying the bacteria to the oxygen rich air-media interface and also act as protecting device from UV light (Ross et al., 1996). Since bacterial cellulose has high purity and unusual physio-chemical characteristics such as high crystallinity, degree of polymerization, tensile strength and thermal stability, it has been used for different application area compared with wood cellulose (El-Saied et al., 2008; Yoshinaga et al., 1997). Bacterial cellulose has been applied as stereo headphones, stabilizer of emulsions in cosmetics, repairs of old documents, coating compositions, food additives and temporary artificial skin (Jonas and Farah, 1998). Bacterial cellulose have also been considered as an ideal candidate for developing wound care dressing material because it has non-toxic properties, and can be synthesized according to the shape of the mold (Czaja et al., 2006).

Previously, we showed optimal conditions for pilot-scale bacterial cellulose production by using *Gluconacetobacter hansenii* TL-2C in citrus juice media (Jeong et al., 2007). Recently, the strain was re-identified as *Gluconacetobacter rhaeticus* via 16S rRNA sequencing (Seong-Ho Kim, personal communication). In this work, we investigated the microstructure, chemical structure, water absorption ability and water maintenance ability of bacterial cellulose producing by *G. rhaeticus* TL-2C so as to confirm its possibility as wound care dressing material. As far as we know, this is the first report for physiochemical characteristics of bacterial cellulose producing by *G. rhaeticus*.

EXPERIMENTAL PROCEDURE

After a pilot-scale bacterial cellulose production as previously described (Jeong et al., 2007), it was washed with distilled water. Isolated cellulose was treated repeatedly with 0.1 N NaOH and 0.1 N HCl for removing impurity, and then it was freeze-dried and ground to a fine powder using mortar. Microstructure of the cellulose was determined by using scanning electron microscope (JSM-6335F, JEOL). Diameter of the purified cellulose fiber was showed to be about 40 to 50 nm (Figure 1A). This clearly showed that the cellulose production by *G. rhaeticus* TL-2C had nanofiber structure and the cellulose had similar

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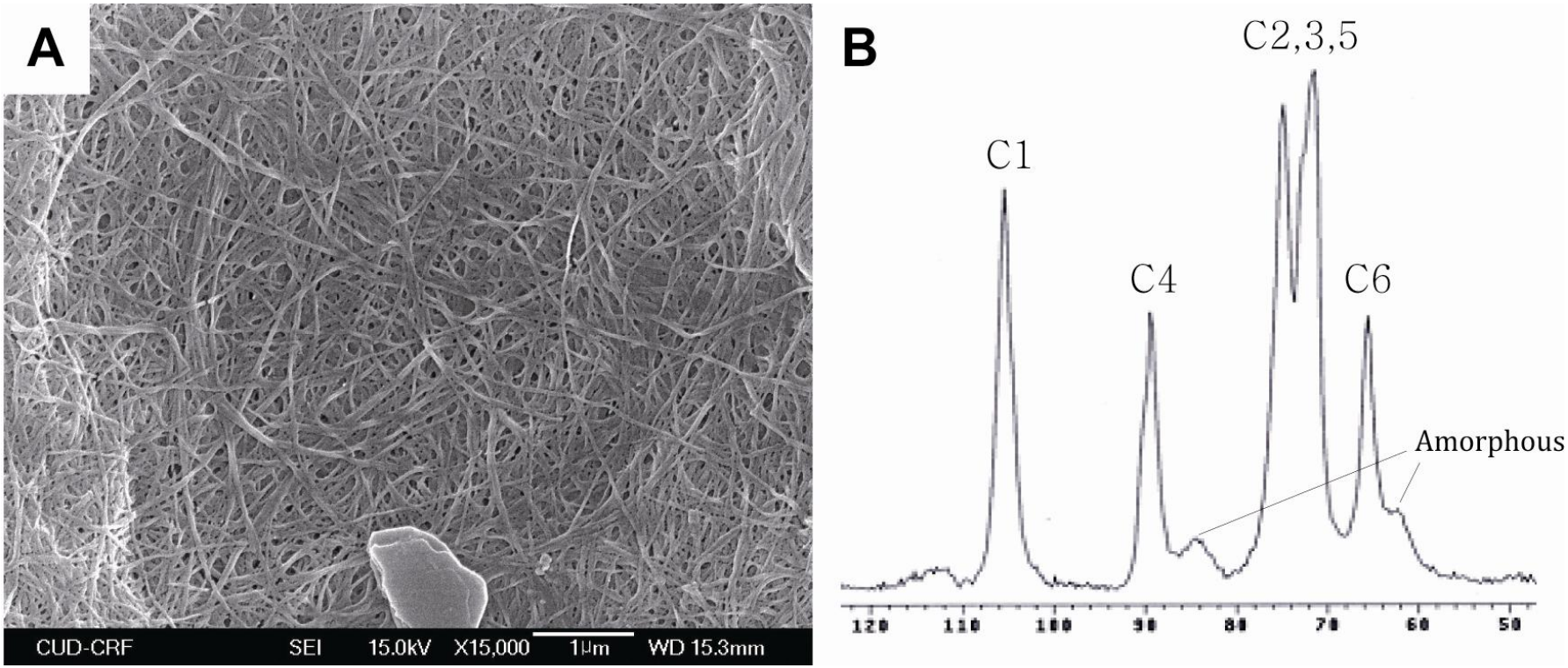

Figure 1. Microstructure and chemical structure of bacterial cellulose producing *G. rhaeticus* TL-2C. (A) Scanning electron micrograph of the nanofibrillar structure. (B) Solid phase 13C-NMR spectra by using FT-NMR spectrometer (600 MHz, Inova 300WB, Barian , USA).

microstructure with other bacterial cellulose (Wan et al., 2006).

RESULTS AND DISCUSSION

To identify chemical structure of the cellulose, solid state 13C-NMR (600 Varian MHz, USA) was performed (Figure 1B). Cellulose crystallites are believed to be irregular because a significant portion of the cellulose structure shows amorphous regions (Park et al., 2010). Solid state 13C-NMR showed amorphous peak of C-4 and C-6 and crystallinity index (relative amount of crystalline material in cellulose) showed 75.4 by using C-4 peak separation analysis. Crystallinity index was calculated by dividing the area of the crystalline peak (87 to 91 ppm) by the total area assigned to the C4 peak (81 to 91 ppm). This showed a similar crystallinity index with *G. hansenii* ATCC 10821 (Park et al., 2010).

We also investigated water absorption ability of purified bacterial cellulose. Freeze-dried bacterial cellulose was treated by sonication with distilled water for swelling. The result indicates that the water absorption ability of bacterial cellulose (131.5 ± 7.2 mg water/mg dry cellulose) was 19-fold higher than α-cellulose (6.81 ± 0.1 mg water/mg dry cellulose). Figure 2A shows the dry bacterial cellulose powder and water swelled bacterial cellulose. Water maintenance ability was investigated on 65% relative humidity conditions in desiccators for 40 days (Figure 2B). 16 days was required for reducing moisture content of bacterial cellulose to 50% against eight days required for α-cellulose. Hence, the bacterial cellulose had

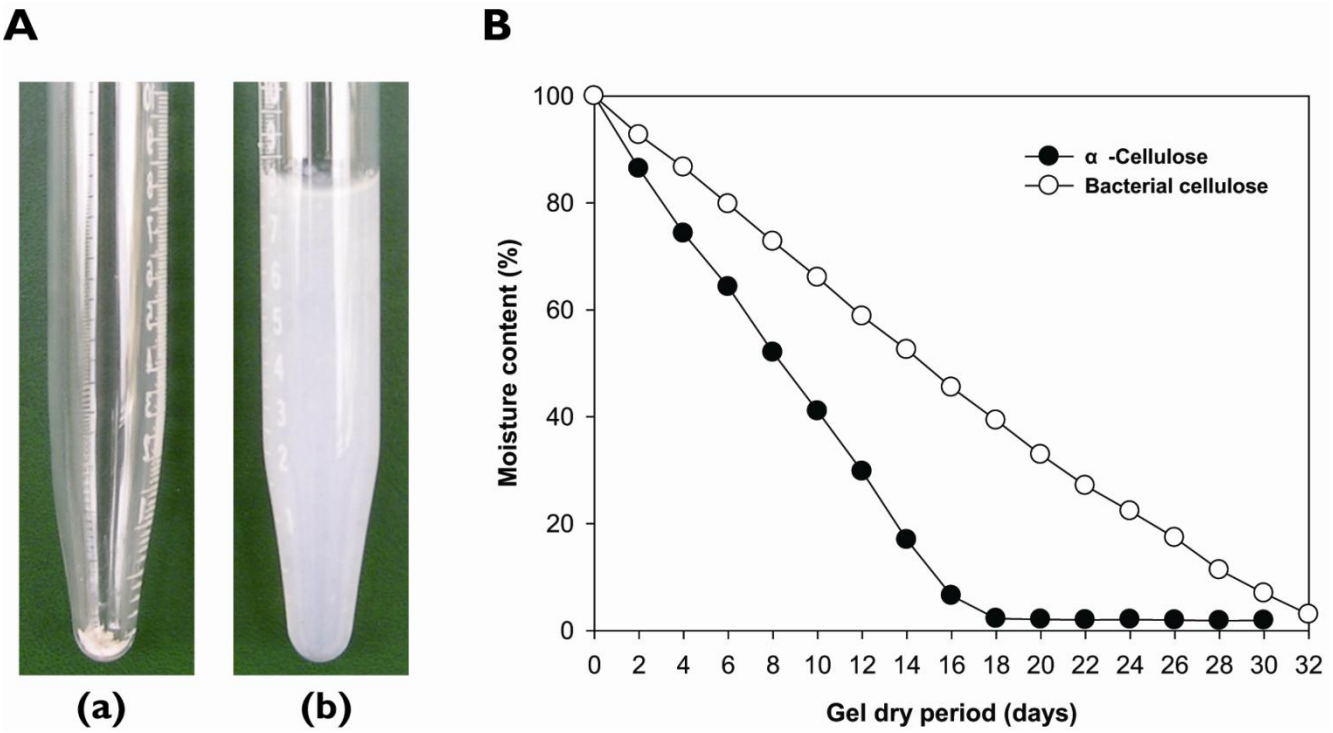

Figure 2. Water absorption and maintenance ability of bacterial cellulose producing *Ga. rhaeticus* TL-2C. (A) Changes in appearance and volume of bacterial cellulose by water absorption; (a) freeze-dried bacterial cellulose powder and (b) gel-like water swelled bacterial cellulose. (B) Changes in moisture content of bacterial cellulose and α-cellulose.

two-fold higher water maintenance ability than α-cellulose.

In conclusion, microstructure and chemical structure of bacterial cellulose producing *G. rhaeticus* TL-2C is similar with other bacterial cellulose such as *Gluconacetobacter xylinum*. The bacterial cellulose producing *G. rhaeticus*

TL-2C is ultra water absorbent, and also has strong water maintenance ability. These properties suggest that bacterial cellulose producing *G. rhaeticus* TL-2C can be developed as wound care dressing material.

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