CELLULOSE PULP AS A SOURCE FOR NANOCELLULOSE FIBER

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Introduction

In pulp and paper industry, cellulose is a substance which remain after completing the pulping and bleaching processes. It is renowned as the most abundant polymer having an annual production over 7.5 x 10^{10} tons (French *et al.* 2004). The first isolation of cellulose was discovered by Anselme Payen in 1838 (Payen 1838). Many methods were used in order to extract the cellulose such as alkali/acid treatment and chlorine free extraction (Das *et al*. 2014, Simone et al., 2012, Nazir *et al.*, 2013, Alemdar & Sain, 2008). At this stage, a huge portion of lignin and carbohydrates have been removed from cell walls. Cellulose pulp contains cellulose which is the main structural constituent of plants, linear polysaccharide of beta (1→4) linked D-glucose units and the frequent molecular weight varies over 1,000,000 g/mole. In practice, cellulose pulp can be derived from woody, non-woody and agro-waste fibers. The woody materials can arise from either softwood or hardwoods such as pine or eucalyptus, from non-woody fibers which comprise of kenaf, rosselle, bamboo and more while agro-waste fibers include pineapple leaves, oil palm empty fruit bunches, oil palm frond, oil palm trunks, rice husks, wheat straws, soy hulls and sago residues (Das *et al.,* 2014, Simone *et al.,* 2012, Nazir *et al.*, 2013, Alemdar & Sain, 2008). Therefore, cellulose pulp is an appropriate raw material for nanocellulose fiber production.

The production of cellulose pulp

In order to obtain cellulose pulp, pulping and bleaching processes need to be accomplished (Eriksen *et al*. 2008; Lindström & Ankerfors 2009). Pulping means the process to transform the chip of raw materials into individual fibrous pulps form under identified conditions such as pressure, temperature and period (Smook 1992). The conditions are very crucial in order to lead the dissolution of a substantial amount of lignin which cemented the cell wall together. Lignin is a random polymer network that connecting two major biopolyme components, cellulose and hemicellulose (Clark 1985). Unbleached pulps are obtained after completing the pulping process. These pulps will allow better bonding during the formation of customized paper products like tissue, paper or board. In general, there are three types of pulping process; namely chemical, mechanical and combination pulping processes which are applied according to the target pulp product applications (Smook 1992).

The next step is bleaching process that whitens the unbleached pulp with minimal degradation of cellulose. The effectiveness of bleaching is influenced much by previous pulping process, pulp fiber species and end usage of the bleached products (Smook 1992). A series of stages which is called bleaching sequences need to be carried out in several steps such as DEDED, DEpD and DEDEH in order to achieve the target value for cellulose pulp in terms of pulp viscosity, brightness and kappa number.

The characteristics of cellulose pulp

The composition of cellulose pulp varied based on the type of raw materials, type of pulping process and type of bleaching process as well. The composition of pulp from various sources are shown in Table 1.

Table 1. Chemical compositions of softwood and hardwood pulp (Spence et al. 2010).

Pulp type	Cellulose	Hemicellulose	Lignin
Softwood			
Unbleached softwood	65.2 ± 0.8	20.1 ± 0.1	13.8 ± 0.7
Bleached softwood	79.2 ± 0.2	20.0 ± 0.1	0.8 ± 0.1
Hardwood			
Unbleached hardwood	78.0 ± 0.5	19.3 ± 0.1	2.4 ± 0.4
Bleached hardwood	78.0 ± 0.2	20.3 ± 0.1	1.3 ± 0.1

Fully bleached pulp that is cellulose pulp can reach as high as 94 compared to unbleached pulp which is only 15 Elrepho units (Smook 1992).

Cellulose pulp for nanocellulose

Cellulose pulp has high potential to penetrate more various industrial modern technologies in terms of information technology, biotechnology and nanotechnology as well (Kim *et al*. 2015). For instance, cellulose is also a well-known material in nano-medical applications for treating renal failure and also for the making of wound care, encapsulation and implant material (Hoenich 2006). Vigilant process for both pulping and bleaching must be carried out in such a way that crystalline or amorphous portions are preserved which finally will be tailor-made to certain production.

Chipping of bamboo in order to obtain 2-3 cm width of chip diameter to ease the penetration of chemical during pulping process.

Pulp digester is used for pulping process.

Unbleached pulp obtained after pulping process accomplished.

The pulps after a sequence of bleaching stages completed which the brightest is the cellulose pulp.

Conclusion

The availability of cellulose from many part of plants and it tremendous characteristics will greatly enhance the production of nanocellulose for high technology application in worldwide areas.

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