

# CHAPTER I

## INTRODUCTION

### I.1. Backgrounds

Nanocrystalline cellulose (NCC) is a nano size cellulose material. The raw materials that are used for the NCC production should have high cellulose content, such as wood, cotton, straw, and etc.(Mandal and Chakrabarty, 2011). NCC has been used for various industrial applications such as in pharmaceutical, health, food, chemical, and etc. (Mantouw, 2014). For the chemical application, NCC can be converted into aerogel, reinforcing material in composite, building material, absorbent, oil emulsifier in water, coating agent, electronic component, etc. (Nugroho, 2014, Subyakto et al., 2009). In this study, NCC is used as drug carrier for antibiotic, particularly tetracycline. One of the advantages of using NCC as drug carrier is it can easily be degraded in human body (Li et al., 2012). In the pharmaceutical application, NCC usually used as drug carrier for liquid medicine.

Cellulose is the main component for the NCC production, and it can be obtained from various kinds of lignocellulosic materials, such as agriculture waste, plantation waste, and some of industrial waste, which contain natural fibre. In this study, we used passion fruit peels waste as the precursor for the production of NCC. Nationally, passion fruit production in Indonesia reaches 99.000 tons/year. West Sumatera Province is the biggest passion fruit producer which reaches 53% from the total national production, then followed by South Sulawesi (24%) and North Sumatera (23%). The average of passion fruit industry needs 10-15 tons passion fruit per day and it will produce around 2.5-4 tons of peels waste per day (Sagala, 2010). To the present, the passion fruit peels waste has not been

utilized as the precursor for any industrial processing except as composting material (Supriyatna and Sihite, 2006). Therefore, the utilization of passion fruit peels waste as alternative raw material in NCC production will add additional value for the passion fruit industry.

Passion fruit peels contain natural fibre which is classified as lignocellulosic material (Subyakto et al., 2009). The main compounds of lignocellulosic material are lignin, hemicellulose, and cellulose. The existence of lignin and hemicellulose in the lignocellulosic material give negative effect on the NCC production process, therefore, the pre-treatment to remove lignin and hemicellulose is required before the process (Sjöström, 1993). Several pre-treatment technologies are currently available for lignin and hemicellulose removal such as ammonia fibre explosion (Chundawat et al., 2012), CO<sub>2</sub> explosion (FitzPatrick et al., 2010), steam explosion (Heiss-Blanquet et al., 2011), ionic liquids (ILs) (Yang et al., 2013), organic solvent (Wettstein et al., 2012), hot water (Holopainen-Mantila et al., 2013), dan acid hydrolysis (Nuruddin et al., 2011). Each pre-treatment process has advantages and disadvantages which need to be suited with the raw material used. The treatments commonly used for the production of NCC from lignocellulosic material are steam explosion (Cherian et al., 2010), acid hydrolysis (Mandal and Chakrabarty, 2011), and enzyme-assisted hydrolysis (Henriksson et al., 2007). Using those pre-treatment processes, high purity NCC can be obtained.

This study observed the suitability of the use of passion fruit peels waste as raw material for the production of NCC. The best condition for the NCC production was determined from the highest yield of NCC, which was subsequently used for the adsorption and desorption of tetracycline antibiotic. The pre-treatment process used in this study consists of

dewaxing, delignification, and alkaline-peroxide, while the acid hydrolysis process was used for the NCC production.

In the adsorption of antibiotic, the effects of the mass of NCC and adsorption temperature in adsorption isotherm were studied, while in the kinetic study, the influence of tetracycline initial concentration and adsorption time in adsorption kinetic were investigated. The rate of release of tetracycline was investigated through desorption kinetic of this antibiotic in simulated body fluid.

## **I.2. Objective**

- a. To study the effect of sulphuric acid concentration and temperature in the NCC production process from passion fruit peels waste.
- b. To study the isotherm and kinetic of adsorption of tetracycline antibiotic on the NCC.
- c. To study the kinetic desorption of tetracycline antibiotic from the NCC.

## **I.3. Problems Limitation**

- a. The best condition for NCC production was determined based on the highest yield of NCC, and then it was used to produce NCC for adsorption and desorption process.
- b. Simulated body fluid (SBF) was used as fluid of human body in desorption process. The composition of the SBF were  $\text{Na}^+$  (142 mmol/l),  $\text{K}^+$  (6.5 mmol/l),  $\text{Mg}^{2+}$  (1.5 mmol/l),  $\text{Ca}^{2+}$  (2.5 mmol/l),  $\text{Cl}^-$  (148 mmol/l),  $\text{HCO}_3^-$  (4.2 mmol/l), dan  $\text{HPO}_4^{2-}$  (1 mmol/l).