CHAPTER I
INTRODUCTION

Some of the most difficult problems facing scientists today are economic and environmental concerns. At present, the primary energy that used in many activities come from fossil fuels such as coal, oil, and natural gas. They release carbon dioxide (CO_2) which is a greenhouse gas and cause of global warming. From this result, many researchers try to replace fossil fuels by renewable energy (Kumar *et al.*, 2009). This energy comes from natural resources such as solar energy, wind, water, and biomass. Biomass is organic materials that can be used to produce biofuels. They can reduce greenhouse gas emissions and they come from woods, plants, energy crops, and agricultural waste (NREL, 2012). The first generation biofuels is food crops such as corn, soybean, grain, etc. However, this generation has a competition for land that used for food and fuel, higher food price and lack of water in some regions. From this impact, researchers try to develop biofuels from non-food biomass. Then, the second generation of biofuels comes from non-food biomass or lignocellulosic biomass (Sims *et al.*, 2008). It includes agricultural waste such as corn stover, sugarcane bagasse, and crop straw, forest residue, energy crops such as grasses and short rotation forests (Lopes *et al.*, 2013).

Lignocellulosic biomass is composite materials. They have three biopolymers which composed of cellulose, hemicellulose, and lignin (Brandt *et al.*, 2013). The main problem of lignocellulosic biomass is that enzyme cannot access to cellulose. The way to convert lignocellulosic biomass to biofuels is changing cellulose to fermentable sugar or glucose. But, lignin is an outside layer of cellulose and hemicellulose and has a strong structure for protect plants cell destruction (Kumar *et al.*, 2009). These are a result of enzyme cannot go through cellulose. Then, pretreatment is the way to break down lignin and enzyme can access and digest cellulose to fermentable sugar (Holm and Lassi, 2011).

Several techniques have been developed to the pretreatment of lignocellulosic biomass. The techniques of pretreatment are physical, chemical, physicochemical, and biological pretreatment (Amarasekara, 2014). Among the techniques proposed, physicochemical pretreatment such as ionic liquid pretreatment has received much attention in the past few years, since it combines with physical and chemical pretreatment.

Generally, the solvents used in pretreatment are acid such as nitric acid (HNO_3), hydrochloric acid (HCl), and sulfuric acid (H_2SO_4) because they give high glucose yield and solubilize hemicellulose. However, it has some drawbacks. Since it can form the fermentable inhibitors, be corrosive the equipment and be dangerous (Brodeur *et al.*, 2011). For solving these problems, ionic liquids are alternative choice. The main properties of ionic liquid are liquid at room temperature, negligible vapor pressure, non-flammability, good thermal stability and non-polluting (Short, 2006; Zhang *et al.*, 2012). Their structures compose of cation and anion. Thus, ionic liquid properties can be controlled by selection of cation and anion (Simmons, 2013). Moreover, they can be used in a wide variety of applications such as solvent in catalytic reaction, separation process, additives, and dissolution of cellulose (Wilkes, 2004; Short, 2006). From these results, ionic liquids are the way to replace the conventional solvents.

Recently, many researchers studied the use of acid in ionic liquid as a catalyst for high total reducing sugar yield. They found that acid is more effective in hydrolysis of lignocellulosic biomass with improved total reducing sugar (TRS) yield under mild conditions (Li *et al.*, 2008; Zhang *et al.*, 2012). Furthermore, adding acid is a process for direct production of fermentable sugars in ionic liquid solution. This process can be divided into two steps. Firstly, dissolution of lignocellulosic biomass in ionic liquid solution. In this step, ionic liquids and acid disrupt the intra- and intermolecular hydrogen bond of biomass and decrystalline of cellulose. The second step is acid-hydrolysis of dissolved cellulose in ionic liquid solution. This step is acid catalyzing the hydrolysis of glycosidic bond and cleave cellulose and hemicellulose into sugar. Therefore, acid is the important part to increase total reducing sugar yield (Binder and Raines, 2010; Zhang *et al.*, 2012).

The purpose of this work is to study the aqueous ionic liquid pretreatment on Napier grass and the effect of acid type combined with ionic liquid pretreatment on the total sugar yield. In addition, the optimal conditions of acidic aqueous ionic liquid were investigated. The variables including the concentration of acidic aqueous ionic liquid, pretreatment time, and temperature were optimized. Finally, structure of Napier grass before and after pretreatment was also examined.