CHAPTER V

CONCLUSION AND RECOMMENDATION

1. Conclusion

The choice of bacterium for acetic acid production from carbohydrate is *Clostridium thermoaceticum*. *Clostridium thermoaceticum* is a spore forming, obligate anaerobic, thermophilic bacterium and homoacetate fermenting. The first reason of choosing this bacterium is that its ability to convert glucose, fructose and xylose which can be derived from lignocellulosic biomass to acetic acid and it can produce high yields of acetic acid. The theoretical process can convert 3 moles of acetic acid from 1 mole of glucose. Second reason is that the bacterium is thermophilic, which may help eliminate potential problems of contamination during long fermentation period. In addition, it is an anaerobic process, and thus should be cheaper than aerobic process traditionally used for making vinegar.

The carbohydrate source of choice for acetic acid production by *Clostridium thermoaceticum* is blackstrap molasses. Blackstrap molasses is a by-product of the manufacturing or refining sugar either from cane beet or other starch containing pulp. It is sticky and contains high sugar. One reason for choosing this is that the blackstrap molasses is a low price biomass and contains high sugar. There are 46 sugar refinery plants in Thailand, which more than $2x10^6$ ton of molasses is produced as a by-product from $47x10^6$ ton of cane press quantity of the sugar refining factories in Thailand.

This study showed that 1:0 diluted molasses can not be utilized for the production of acetic acid because of high sugar content or high inhibitor concentration. Molasses was necessary to be diluted, removed of colorant and supplemented with nutrient to support growth and acetic acid production. Pretreatment diluted molasses with nutrient supplement was studied. The ingredients of FTGB except sugar were added to molasses prior to use as the substrate fermentation. In addition, each separate ingredient of yeast extract, sodium chloride, sodium thioglycollate, L-cysteine and

casitone as well as the combination of yeast extract, sodium chloride, sodium thioglycollate, L-cysteine and casitone were added to study the most effective ingredient in acetic acid production from molasses. The result showed that two ingredients combination of casitone and yeast extract was found to be the most effective ingredient. Acetic acid concentration was found at 3.36 mg/ml in molasses supplemented with casitone and yeast extract.

The study was conducted to further improve the production of acetic acid from molasses by additional of phosphate. The result showed that the addition of 120 mM PO_4 in activated charcoal pretreatment of 1:50 diluted molasses and ingredient of STG yield acetic acid concentration of 4.56 mg/ml.

Activated charcoal pretreatment of 1:50 diluted molasses with two combination of casitone and yeast extract supplementation and the addition of 120 mM of phosphate in batch fermenter represent good growth and acetic acid production (5.52 mg/ml). Accordingly, the cost calculated was found to be 34.6 bath/g acetic acid. This production cost is expensive comparing to commercially available acetic acid.

However, the acetic acid production by petroleum processes cause pollution and use non-renewable raw material. The crisis arises because petroleum products have reached such high price and are consumed more rapidly than they are being replaced. Considerable interest has been focused on using biomass as substrate to replaced petroleum used. Biomass is a renewable energy resource derived from the carbon waste of various human and natural activities. It is derived from numerous sources, including the by-products from the timber industry, agricultural crops, raw material from the forest, major parts of household waste and wood. Biomass does not add carbon dioxide to the atmosphere. It absorbs the same amount of carbon in growing as it releases, when consumed as a fuel. Biomass is an important source of energy and the most important fuel worldwide after coal, oil and natural gas. Therefore, the development of acetic acid production from biomass is the most important as it utilizes very highly potential biomass energy source of Thailand.

2. Recommendations

There are varieties of waste products in Thailand for example corn steep liquor, distiller's soluble, sulfite waste liquor, etc. which, can be used as substrate for fermentation of acetic acid. In theory, Continuous fermentation systems are more productive than batch fermentation systems. This will decrease cost of acetic acid production. By introducing acclimated culture method acetic acid production can be increased. At present, solar hot water system has high efficiency and easy to use. The hybrid fermentation system with solar hot water will decrease cost of acetic acid production compare to electrical water.