# CHAPTER V
# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Conclusions

From the experiment, the best novel solid acid catalyst from the sulfonation process for biodiesel production was 10 g of p-toluenesulfonic acid activated on pretreated corncob, yielding biodiesel yield of 80.4% at 60°C, 8h. Even though it gave biodiesel yield lower than the catalyst activated by concentrated sulfuric acid, it catalyzed the reaction faster and reduced the reaction time from 8 to 2 h, since it has lower acid site just 0.985 mmol/g and has a problem of acid site leaching, but it has very high surface area of 240 $m^2/g$ and suitable pore diameter about 3 nm. Furthermore, when the reaction temperature increased from 60 to 80°C, the high biodiesel yield was obtained within 1 h. The result indicated that the high activity could be ascribed to high acid quantity and strong acidity that corresponded with more $-SO_3H$ groups as acid sites, high surface area, and suitable pore diameter of the prepared catalyst.

## 5.2 Recommendations

In the part of sulfonation, temperature and time should be extensively studied to confirm the best condition of sulfonation process of activated catalyst from p-toluene sulfonic acid. In addition, other solid materials and acids should be studied.

In the part of biodiesel production, methanol to oil ratio should be varied to optimize reaction condition of biodiesel production process in the presence of the catalyst activated by p-toluenesulfonic acid.

The reusability of the solid acid catalyst is very important, other techniques and information should be required. Carbonization or pyrolysis may be utilized to increase the strong bond between lignin and $-SO_3H$ group in sulfonation reaction.