CHAPTER 5

SUMMARY AND CONCLUSION

5.1 SUMMARY

The present study investigated the ultrasound assisted methods for the pretreatment of SCB for bioethanol production. SCB was subjected to different pretreatment methods such as ultrasound assisted ammonia, dual metal salt, ultrasound assisted metal salt and ultrasound assisted metal chloride pretreatment. The influence of different operating parameters such as SCB dosage, liquid to solid ratio, temperature, time and H$_2$O$_2$ concentration was investigated. Among the various pretreatment studied, ultrasound assisted metal salt and metal chloride pretreatment showed maximum cellulose recovery and delignification. The dilute acid hydrolysis of pretreated SCB was carried out and sugar production and inhibitors generation at different acid concentrations was also studied. The hydrolyzate obtained was subjected to fermentation using *Saccharomyces cerevisiae*.

5.2 CONCLUSION

In ultrasound assisted ammonia pretreatment (UAAP), hemicellulose and lignin removal from SCB were found to be 58.14 and 60.50%, respectively. The maximum cellulose recovery and delignification were obtained at the optimum conditions (particle size: 0.274mm, sonication time: 45 min, ammonia concentration: 10%, LSR: 10 mL/g and temperature: 80°C). Using ultrasound assisted acid hydrolysis, 78.62% and 50.51%
theoretical conversion of glucose and pentose sugar, respectively, were achieved. The maximum ethanol production of 9.6 g/L was obtained and this corresponds to 77.9% of theoretical yield.

SCB was pretreated with different combinations of metal salts. Among the different combinations, MnSO$_4$·H$_2$O and ZnO showed better performance. The synergistic effect of H$_2$O$_2$ with the dual metal salt favored the maximum delignification at low substrate dosages. The maximum cellulose recovery and delignification was obtained with 1% H$_2$O$_2$, 1g SCB dosage, 30 min reaction time, 100°C and the molar ratio of metal salt to H$_2$O$_2$ 0.5:100 g/mL, respectively. The maximum concentration of xylose (11.62±0.21 g/L) and arabinose (3.58±0.17 g/L) was obtained when SCB was treated with 2% H$_2$SO$_4$ at 121°C for 15 min. Under these conditions, the concentration of furfural and acetic acid were 1.19±0.11 and 0.68±0.02 g/L, respectively. The fermentation of hydrolyzate produced 13.1 g/L of ethanol and this corresponds to 84.3% of theoretical yield. The yield of ethanol obtained at the end 72 h was 0.184 g/g SCB.

The pretreatment of SCB was carried out using ultrasound and with different metal salts. The results showed better performance with ultrasound assisted titanium dioxide pretreatment (UATP). The maximum cellulose recovery and delignification of 94.02 and 78.72% were observed with 1% H$_2$O$_2$, 4g SCB dosage, 60 min ultrasound time, 75°C and 2:100 g/mL molar ratio of metal salt to H$_2$O$_2$. The major degraded products such as vanillin, syringol, coniferyl alcohol, sinapyl alcohol, and guaiacol were observed. The pretreated SCB was hydrolyzed using dilute H$_2$SO$_4$ and the liquid hydrolyzate containing 28.32±0.74 g/L of fermentable sugars and 1.69±0.73 g/L of inhibitors was obtained. The maximum of 13.24 g/L of bioethanol was found to be produced during fermentation, which is equivalent to 91.68% of theoretical yield.
The pretreatment of SCB with ultrasound assisted FeCl$_3$ (UAFP) showed the maximum cellulose recovery and delignification of 94.94 and 79.42% at a particle size 0.274 mm, H$_2$O$_2$ concentration of 1.5%, substrate dosage of 3g, ultrasound time of 75 min, molar ratio of FeCl$_3$ and H$_2$O$_2$ 1:100 and at 60°C. The maximum delignification was observed at a substrate dosage of 3g, which was due to the higher interaction effect of SCB with FeCl$_3$ and H$_2$O$_2$ in the presence of ultrasound. The hydrolysis of pretreated SCB using dilute H$_2$SO$_4$ gave 24.31 g/L of sugars with 2% H$_2$SO$_4$, which showed the maximum catalytic efficiency of 11.85 g/g. The fermentation of hydrolyzate produced 11.58 g/L of ethanol and this corresponds to 93.4% of theoretical yield. The yield of ethanol obtained at the end 72 h was 0.231 g/g SCB.

The comparative analysis of the pretreatment methods studied indicated that the ultrasound assisted ferric chloride pretreatment and ultrasound assisted titanium dioxide pretreatment as the best methods, which showed higher cellulose recovery and lesser inhibitor production during acid hydrolysis.

5.3 SCOPE FOR THE FUTURE WORK

The present study dealt with the production of bioethanol from SCB using various pretreatment methods. The proposed technique may be improved further by carrying out the following works:

- The pretreatment of SCB can be carried out using nano metal catalysts.
- Genetic engineering and molecular studies can be carried out for the saccharification and fermentation to develop single step method for the production of bioethanol from pretreated SCB.
- The pilot scale production of bioethanol from SCB can be attempted based on the results reported in this study.