CHAPTER VI

CONCLUSIONS AND RECOMMENDATIONS

This chapter presents brief review of chapter I to IV, a conclusion and recommendations.

6.1 Brief Review of Chapter I to IV

The primary objective of this research is to study the effects of the combination of xylanase, laccase and H_2O_2 on lignin removal from teak veneer from commercially grown teak with minimum changes in its natural texture. The structure and composition of wood was review in chapter II along with various methods and chemical used in removing lignin. Most of the research done in this area is in the pulps and paper field. H_2O_2 and two enzymes, xylanase and laccase, were selected. The image processing technique was selected as an indirect method to measure the amount of lignin removed as a direct lignin measurement method cannot be used. The dependent and independent variables were selected. The experiments were carried out as described in chapter IV.

6.2 Conclusions

The purpose of this research is to improve the color quality of commercially grown teak veneer. The first part of the study was conducted under factorial experimental design which reveals that xylanase and laccase either separately or in combination with each other will not help improve the color quality of teak veneer. On the contrary, it darkens the veneer sample. The H_2O_2 does help improve the color quality that is it helps removing lignin. The amount of lignin removed increases with H_2O_2 concentration. Time has a significance effect on lignin removal. The amount of lignin removed increases with time; however, the rate of lignin removed declines with time. The mixture of xylanase at 0.25 u/ml or higher and H_2O_2 will remove lignin however some of these combinations will reduce lignin removal ability when

compared with the sole H_2O_2. The mixture of laccase and H_2O_2 lower the performance of H_2O_2. Therefore, the extended research was utilized.

In the extended research, xylanase was verified that it can cleave xylan at the condition the research was conducted. Different approaches were used to incorporate xylanase and laccase into the experiments in a way that they can help improve the H_2O_2 performance. The first part was the use of the mixture of low concentration xylanase and H_2O_2. The experiments were performed at 0.05 u/ml xylanase and 10% H_2O_2 at 60°C and pH 6.5 for 4 hours. This combination removed lignin at the average of 24.34% in gray scale, a 10% improvement over the sole 10% H_2O_2.

The next part of the extended research was the use of xylanase and H_2O_2 mixtures in sequence. It was found from this extended research that xylanase should be used at low concentration of 0.05 u/ml and lower and that xylanase works better in sequence with H_2O_2. Laccase was also found that it helps removed lignin better at low concentration of 0.05 u/ml and lower, than at high concentration of 0.25 u/ml and higher. It was also found that laccase help remove lignin better when applied after the samples were treated with xylanase. The suitable concentration for H_2O_2 was found to be between 8% and 10%. Table 5.13 provides a range of results for many xylanase, laccase and H_2O_2 combinations. The best combination from this research is the sequent combination where the veneer samples were treated in 0.05 u/ml xylanase at room temperature and pH 4.5 for 30 minutes followed by the treatment with the mixture of 10% H_2O_2 and 0.05 u/ml laccase at 60°C and pH 6.5 for 4 hours. This combination results in 26.4% increase in gray scale, a 19.3% improvement over the sole 10% H_2O_2.

Depending on the amount of lignin that needed to be removed, H_2O_2 can be chosen from 5 to 10% with their sets of enzymes and methods of treatments.

6.3 Recommendations and Future Research

1. The effect of wood sample from different sample of population should be investigated.

2. The study should be conducted further on different wood species.