CHAPTER V

CONCLUSIONS AND RECOMMENDATION

5.1 Conclusion

To improve their compatibility, the study investigated the impact of NR's mastication period on the tensile properties and melt flow index (MFI) of the PLA/NR blend. The ratio of the PLA/NR blend was maintained at a constant weight percentage of 60/40 (wt.%). It was discovered that increasing the duration of NR masticating leads to a higher MFI of the polymer blend. The results of the tensile test showed that the NR mastication duration of 10 minutes had the maximum percentage of elongation at break, which was measured at 231.33 ± 34.43%. Thus, a mastication duration of 10 minutes was chosen for further investigation, as it was found to be the optimum period to significantly improve PLA's toughness properties.

After a suitable PLA/NR blend condition was achieved, the effects of rice straw (RS) content on the MFI, tensile properties, and morphology of biocomposite films were studied. The ratio of PLA and NR in the blend was kept constant at 60/40 wt.%. The blend was filled with RS fiberr at concentrations of 3, 5, and 10 wt.%, respectively. Observations revealed numerous holes in the biocomposite film, which contains 10 weight percent RS (PLA/NR/10%RS). According to the MFI results, increasing the RS content to 10%wt. resulted in an MFI of 37±0.79 g/10 min, which was unsuitable for producing a smooth film. Normally, the appropriate MFI range for cast film is approximately 9-15 g/10 min. Consequently, the biocomposite films comprising 3 and 5 weight percent were further examined. As the RS content increased, the biocomposite films' tensile strength and modulus decreased, but their elongation at break remained higher than PLA's. The morphology of the biocomposite film on the surface fracture under tension was shown to be incompatible.

The biodegrading behavior of the biocomposite films was assessed by burying them in soil for a duration of 3 months. The PLA film had the lowest percentage weight loss of 3.33%, indicating a relatively slow degradation rate in comparison to all the biocomposite films. The film containing 5 wt.% of RS exhibited the highest weight loss percentage of 8.30%, which is consistent with the result of decreased molecular weight. The morphological analysis reveals numerous pores and fungus growth on the film surface after burial in the soil. The chemical composition analysis using EDX revealed the presence of nitrogen and an increase in oxygen content, while the carbon contents decreased during the burial process. The DSC results and the XRD results both showed that PLA had a low level of crystallinity. The addition of NR and RS to the biocomposites resulted in an enhanced PLA crystallinity. All biocomposite films showed an increase in crystallinity after burial in the soil. Consistent with the results on mechanical properties, it was observed that the modulus value tended to increase. This study demonstrates that biocomposite films filled with RS exhibit a higher susceptibility to degradation compared to PLA films.

The biocomposite films were studied and evaluated for their potential agricultural applications including seedling bags and mulch films. Chili plants were cultivated for a period of 3 months. Chili plants grown in bags made from PLA/NR blend and PLA/NR/RS biocomposite films showed higher values of dry weight, stem diameter, total weight of chili fruits per plant, and height compared to plants grown with HDPE and neat PLA seedling bags. In addition, the roots of the chili plant had penetrated the pores in the seedling bags. Particularly, bags produced from biocomposite materials. The root penetration provides an indicator of the efficacy of the seedling bags, which can facilitate and unhindered plant growth. The investigation of the weight loss percentage of the seedling bags after a 3-month period revealed that the seedling bags made from PLA/NR/RS biocomposite film with 5% RS showed the highest percentage loss in weight, specifically 11.29 ± 0.37%. The increase in weight loss percentage after 3 months of chili planting is associated with the decrease in molecular weight. The results demonstrated the highest decrease in molecular weight in PLA/NR/RS biocomposite films with a 5% RS content. The morphological inspection of the film sample, which came from seedling bags used to grow chili plants for three months, shows that the surface of the biocomposites' film degrades more than that of neat PLA. Both the DSC and XRD data showed an increase in the seedling bag films' crystallinity. It is consistent with the observation that the Young's modulus of the film samples cut from the bags after three months of chili planting tends to increase.

The mulch films used for chili cultivation degraded rapidly, starting to degrade within the first month. Over the second month, the film fragmented into smaller pieces, spreading into the soil, and allowing grass and weeds to grow in the cracked areas. Chili plants grown for 3 months using mulch films made from PLA/NR blend and PLA/NR/RS biocomposite films had similar growth rates to those using HDPE films and without films. On the other hand, the study found that the growth rate of chili plants with neat PLA mulch films was significantly lower. The 90-day investigation shows a significant reduction in the molecular weight of PLA phase in all biocomposite films, with physical observations confirming the degradation. The mulch films' percentage weight loss was not available due to film degradation and fragmentation into small pieces that could not be completely recovered. The morphological characteristics of mulch films revealed rough and disorganized surfaces, indicating surface destruction. The DSC results revealed a decrease in crystallinity compared to the film prior to its burial in the soil. Finally, the crystallinity was decreased to a degree where it could not be detected by XRD inspection. As mentioned previously, it was found that biocomposite films were not suitable for mulch film application.

5.2 Recommendation

An investigation of the impact on the environment is essential, particularly the potential effects on soil when the film decomposes. Furthermore, there may be limitations on the future utilization of the film due to its degradation. Hence, it is imperative to select the appropriate film for use.