Development of Biodegradable Packaging with Antimicrobial Properties for Fresh Fruits, from Banana Pseudo-Stem Pulp and *Hal (Vateria copallifera)* Bark Extract

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In Sri Lanka, annually, 30–40% of fruits and vegetables are lost as post-harvest losses, causing a loss of approximately LKR 20 billion to the economy. Among potential causes of spoilage, microbial deterioration remains a primary reason. Therefore, this study aimed to develop biodegradable food packaging with antimicrobial properties against fruit spoilage microorganisms to extend the shelf-life of perishable fruits using banana pseudo-stem pulp and *Vateria copallifera* stem bark extract. The base packaging material was developed using the banana pseudo-stem pulp obtained via a soda-pulping process, and the *V. copallifera* stem bark extract was coated onto the base packaging material. *V. copallifera* bark extraction process was optimized using distilled water, 70% acetone, 99.9% acetone, 70% ethanol, and 96% ethanol. The antimicrobial activity of *V. copallifera* extract was screened using the agar-well diffusion method against *Staphylococcus aureus, Streptococcus pyogenes, Escherichia coli, Pseudomonas aeruginosa, Penicillium* sp., and *Aspergillus* sp. The bacterial strains that showed significantly visible inhibition zones were used to determine the Minimum Inhibitory Concentration (MIC). The biodegradability and practical applicability of the wrapping material were also measured using physical parameters. Based on availability and extraction efficiency, 96% ethanol was selected as the solvent of extraction for the final extraction process. From tested microorganisms, only *Staphylococcus aureus*, *Streptococcus pyogenes*, and *Penicillium* sp. showed visible inhibition zone diameters of 18 ± 0.8 mm, 20 ± 0.5 mm, and 15 ± 0.6 mm, respectively. The MIC values for *S. aureus* and *S. pyogenes* were determined to be 0.25 mg/mL and 0.125 mg/mL, respectively. Only 5g of dry pulp demonstrated its required flexibility to effectively cover fruits and was biodegraded within 3–4 weeks under normal atmospheric conditions. The results indicate that the formulated packaging material has promising potential to be an effective antimicrobial and biodegradable packaging, primarily against Gram-positive bacteria and certain fungi.

Keywords: Antimicrobial, Biodegradable, Fruit wrapping, Packaging, Sustainable