Comparison of the Properties of Alginate-Based Edible Packaging Films Containing Ascorbic Acid and Lemongrass (*Cymbopogon citratus*) Essential Oil

K.G. Kaushani[1,2], N.L. Rathnasinghe[1], B.P.S. Rajapakshe[1], N.M.C. Nissanka[3], K.A.A. Dilhari[4], M.M. Weerasekera[3], R.A. Jayasinghe[5], A.H.L.R. Nilmini[1], N.P. Katuwavila[6], and G. Priyadarshana[1*]

[1]Department of Materials and Mechanical Technology, Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka.
[2]Faculty of Graduate Studies, University of Sri Jayewardenepura, Sri Lanka.
[3]Department of Microbiology, Faculty of Medical Sciences, University of Sri Jayewardenepura, Sri Lanka.
[4]Department of Basic Sciences, Faculty of Allied Health Sciences, University of Sri Jayewardenepura, Sri Lanka.
[5]Department of Civil and Environmental Technology, Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka.
[6]Department of Biomedical Science, Faculty of Science, NSBM Green University, Sri Lanka.

[*] *gayanp@sjp.ac.lk*

Biopolymer-based active edible films are regarded as potential alternatives to plastic packaging because of their superior biodegradability, edibility, sustainability, and biocompatibility. In this study, active edible films from alginate (Alg) containing various concentrations (0.5%, 1%, and 1.5%) of active ingredients such as ascorbic acid (AA) and lemongrass essential oil (LEO) were developed using $CaCl_2$ as the crosslinking agent using the casting method. The physical, optical, mechanical, thermal, antioxidant, and antimicrobial properties of the fabricated films were investigated to determine the potential of using them in food applications. The results revealed that the addition of AA and LEO with increasing concentration has increased the film thickness and decreased the moisture content, which ranged from 0.14 mm to 0.30 mm and 26.8% to 10.5%, respectively. Significantly enhanced water resistance was recorded for alginate-based films containing LEO (Alg-LEO) compared to alginate-based films containing AA (Alg-AA) due to the hydrophobic nature of LEO. Although there was a significant decrease ($p < 0.05$) in tensile strength with the addition of AA and LEO, elongation at break was significantly increased ($p < 0.05$) when increasing LEO concentration. Both films showed a total color difference ($\triangle E$), which significantly increased ($p < 0.05$) as a function of antioxidant concentration. The thermogravimetric analysis results showed that LEO was more efficient at improving the thermal stability of the films compared to AA. The incorporation of 1% AA and 1.5% LEO were the most effective concentrations in controlling the growth of *Staphylococcus aureus, Bacillus cereus, Klebsiella pneumoniae*, and *Escherichia coli*, while *Bacillus cereus* being the most susceptible bacteria. The 1.5% Alg-AA films showed stronger DPPH radical scavenging activities (IC_{50} = 50.4 µg/mL) than the 1.5% Alg-LEO films (IC_{50} = 76.9 µg/mL). These results suggest that the developed alginate-based films containing AA and LEO can be used as sustainable and active materials in the food packaging industry.

Keywords: Alginate, Antimicrobial, Antioxidant, Edible Packaging