Analysis of physical and functional properties of starch-based polyphenol incorporated bioplastic

M.Rudhra premdharshan[1]*, S. Vasantharuba[2]

[1]*Department of Agricultural Chemistry, Faculty of Agriculture, University of Jaffna, Sri Lanka.*

[2]*Department of Agricultural Chemistry, Faculty of Agriculture, University of Jaffna, Sri Lanka.*

rudhra.premdharshan@gmail.com

Conventional plastics are slow to degrade and contribute to environmental pollution, while bioplastics offer a sustainable, eco-friendly alternative, reducing waste and promoting environmental stewardship. Starch-based bioplastics are particularly promising for applications such as packaging in agriculture, while antioxidant-incorporated bioplastics enhance stability, functionality, and shelf life, making them a sustainable solution. This research focuses on analyzing the physical and functional properties of starch-based polyphenol incorporated bioplastic with three sample types: bioplastic made from starch (SP0) as control, and starch-based bioplastics with 2% (SP2) and 4% (SP4) polyphenol incorporation. The results for bioplastic samples SP0, SP2, and SP4 showed notable variations across key parameters. The moisture content was 18.4±0.3%, 19.21±0.06%, and 20.45±0.47%, while total solids were 81.6±0.19%, 80.79±0.1%, and 79.56±0.1%, and ash content was 0.21±0.03%, 0.87±0.05%, and 1.33±0.01%, respectively. Thickness and density values for SP0, SP2, and SP4 were 0.35±0 mm, 0.37±0.01 mm, and 0.37±0.01 mm, and 1.21±0.02 g/mL, 1.24±0.04 g/mL, and 1.26±0.02 g/mL, respectively. Tensile strength increased from 5.04±0.08 MPa (SP0) to 8.75±0.07 MPa (SP4), while elongation rates decreased from 10.24±0.12% (SP0) to 6.99±0.01% (SP4). Biodegradation weight loss (%) increased from 6±0.006, 12±0.005, 17.5±0.005, and 25±0.002 in SP0 to 7.87±0.005, 14.8±0.008, 21.7±0.016, and 28.99±0.02 in SP4 at days 5, 10, 15, and 20, respectively. Polyphenol content of SP0 remained constant (0.0002±0.0001) over 20 days, while SP2 showed 0.1304±0.0001 (day 0) declining to 0.1227±0.0053 (day 20), and SP4 decreased from 0.281±0.0003 to 0.2759±0.0003. Antioxidant activity for SP0, SP2, and SP4 at day 0 was 0.63±0.21, 13.11±0.48, and 18.74±0.42, reducing to 0.53±0.11, 11.01±0.64, and 15.66±0.42 by day 20, respectively. Water vapor permeability (WVP) and water vapor transmission rate (WVTR) were 6.56×10^{-12}±0.13 and 4.75×10^{-12}±0.23 for SP0, 6.1×10^{-12}±0.56 and 4.18×10^{-12}±0.46 for SP2, and 5.79×10^{-12}±0.08 and 3.97×10^{-12}±0.18 for SP4, respectively. Overall, these findings illustrate the impact of incorporated polyphenol in the starch-based bioplastics.

Keywords: Starch; Polyphenol; Bioplastic; Biodegradation; Antioxidant activity