



Development and Evaluation of Biodegradable Nursery Cups Using Eggshell Waste Incorporated with Natural Binding Agents

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The increasing use of plastic nursery containers has raised environmental concerns due to their non-biodegradable nature, while large quantities of eggshell waste remain underutilized. This study aimed to develop and evaluate biodegradable nursery cups using eggshell waste reinforced with natural fibers and a biopolymer binder as an alternative to plastic nursery containers. Eggshells were cleaned, sterilized by boiling for 15–20 minutes, dried, and ground into fine powder. Coconut (*Cocos nucifera*) coir and banana (*Musa sp.*) fibers were treated with 5% NaOH and cut into 2–5 mm lengths. A biopolymer matrix was prepared by dissolving gelatin in hot water with glycerin as a plasticizer. Composite mixtures were molded into nursery cups and air-dried for 24–48 h. Four treatments were formulated based on eggshell-to-gelatin ratio and fiber type: T1 (Eggshell + Gelatin + Coconut fiber, 3:1), T2 (Eggshell + Gelatin + Coconut fiber, 4:1), T3 (Eggshell + Gelatin + Banana fiber, 3:1), and T4 (Eggshell + Gelatin + Banana fiber, 4:1). The cups were evaluated for thickness, weight, water absorption, biodegradability, calcium release, and plant growth performance using chili seedlings, with plastic and cocopeat pots as controls. Significant differences ($p < 0.05$) were observed among treatments for physical, biodegradation, and plant growth parameters. Among all treatments, T4 showed the best overall performance with adequate mechanical stability, moderate water absorption, complete degradation within approximately two months, and superior plant growth response. The gradual release of calcium from eggshells enhanced soil nutrient availability without leaving harmful residues. This study demonstrates that biodegradable nursery cups can be successfully produced from eggshell waste combined with natural fibers and gelatin binder. The T4 formulation is recommended as an environmentally friendly alternative to plastic nursery containers, contributing to sustainable waste utilization and reduced plastic pollution in horticulture.

Keywords: Biodegradable nursery cups, Eggshell waste, Natural fibres, Gelatin biopolymer, Sustainable horticulture