



Development of a Phase Change Film with Eggshell-Based Microcapsules for Efficient Nocturnal Heat Release in Quail Chick Farms

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Abstract

Quail are economically important poultry raised primarily for meat and egg production. During the early post-hatch stage, quail chicks are highly susceptible to temperature fluctuations due to their sparse feather coverage and limited ability to regulate body temperature. This project aimed to develop a temperature-regulating film incorporating phase change materials (PCMs) through microencapsulation technology reinforced with eggshell powder. The developed film was designed to absorb thermal energy during the daytime and gradually release stored heat at night, thereby maintaining the brooding environment within the optimal temperature range of 32–35°C. During material fabrication, the ratio of methyl methacrylate (MMA) to ethylene glycol dimethacrylate (EGDMA) was systematically optimized. Experimental results demonstrated that an MMA ratio of 25:75 provided the highest microencapsulation efficiency for the phase change material. The resulting film exhibited effective thermal energy storage and controlled heat release, reducing the diurnal temperature fluctuation within the brooding environment to only 0.81°C. The improved thermal stability significantly alleviated physiological stress in quail chicks, allowing metabolic energy to be preferentially allocated toward growth rather than thermoregulation. Consequently, chicks exhibited significantly greater body weight gain and a higher survival rate compared with conventional brooding conditions. Furthermore, the incorporation of waste eggshell powder as a bio-based reinforcing material enhances the sustainability of the system by valorizing agricultural waste while reducing dependence on external energy sources. Overall, the developed temperature-regulating film represents an environmentally sustainable approach to brooding management that is consistent with the biological and developmental requirements of newly hatched quail chicks.

Keywords: temperature-regulating film, phase change materials (PCMs), microencapsulation, eggshell powder, quail chicks