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DOI: 10.2478/auoc-2025-0006

Ovidius University Annals of Chemistry Volume 36, Number 1, pp. 51 - 57, 2025

Ergothioneine-loaded chitosan nanoscale particles mitigate discoloration and lipid oxidation in frozen yellowfin tuna cubes

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Abstract. The present study was conducted to evaluate the effects of ergothioneine-loaded chitosan nanoscale particles (ECNP) on discoloration and lipid oxidation in yellowfin tuna cubes after 6 months of frozen storage. Tuna cubes were treated with ECNP, chitosan nanoscale particles (CNP), ergothioneine (EGT), or left untreated (control). Lipid oxidation was assessed through the total lipid hydroperoxide (HPO) and thiobarbituric acid reactive substances (TBARS), while myoglobin oxidation was determined based on metmyoglobin (metMb) concentration. Color stability was evaluated by L*, a*, b* values, and the redness index (RI = a*/b*). Results indicated that ECNP treatment significantly suppressed lipid and myoglobin oxidation compared to the control ($p < 0.05$). ECNP-treated samples presented the lowest metMb accumulation (43.85 ± 5.15%), with grade B (good) classification after 6 months of frozen storage. In contrast, the control group displayed the highest level of metMb (71.36 ± 2.95%), which belonged to grade D (unacceptable). CNP and EGT treatments also showed protective effects, but to a lesser extent than ECNP. The RI values strongly correlated with the oxidative indicators (HPO, TBARS, metMb), demonstrating its validity in reflecting the anti-discoloration effect of ECNP. These findings suggest that ECNP treatment can enhance the oxidative stability and color retention of frozen tuna cubes, and thus improving their overall quality during frozen storage.

***Keywords*:** biopolymer; natural antioxidant; sashimi; seafood preservation; *Thunnus albacares*.

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