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Research Paper

Investigating the Effect of Hydroalcoholic Extract of Germanders (*Teucrium polium* l.) and Green Tea Leaves (*Camellia sinensis* l.) on the Chemical and Microbial Parameters of Carp Fish Fillet During Storage at Refrigerator Temperature

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Extended Abstract

Introduction Fish and seafood are among the most nutrient-dense foods, providing high-quality proteins, essential fatty acids (especially omega-3 polyunsaturated fatty acids), vitamins, and minerals. However, their biochemical composition, particularly the high levels of unsaturated lipids and moisture, makes them highly perishable. Post-harvest deterioration of fish is rapid, primarily due to oxidative rancidity of lipids and the proliferation of spoilage microorganisms. These processes lead to undesirable sensory changes, nutrient loss, and potential food safety risks, thereby significantly limiting the shelf life of fish products. To mitigate these challenges, various preservation techniques have been employed, including the use of synthetic antioxidants (e.g., butylated hydroxytoluene [BHT], butylated hydroxyanisole [BHA]) and chemical preservatives. While effective, synthetic additives have raised increasing consumer and scientific concerns regarding their potential toxicological effects and long-term health implications. Consequently, there is a growing interest in natural alternatives derived from plant sources, which are often perceived as safer and more environmentally friendly. *Teucrium polium* (commonly known as mountain germander) and *Camellia sinensis* (green tea) are medicinal plants with a long history of culinary and therapeutic applications. Both are rich sources of polyphenolic compounds, including flavonoids and phenolic acids, which have been reported to exhibit potent antioxidant and antimicrobial properties. These bioactive compounds can scavenge free radicals, inhibit lipid peroxidation, and suppress microbial growth, making them promising candidates for extending the shelf life of perishable foods such as fish. The present study aims to evaluate the efficacy of hydroalcoholic extracts of *T. polium* and *C. sinensis* in preserving the quality of common carp (*Cyprinus carpio*) fillets. Specifically, the effects of these extracts on the chemical (lipid oxidation, pH, total volatile basic nitrogen) and microbial (total viable count, psychrotrophic bacteria) parameters of the fillets will be assessed during 20 days of refrigerated storage at 4 °C. The findings may contribute to the development of natural preservation strategies for enhancing the safety and shelf life of fish products.

Methods Hydroalcoholic extracts were obtained from dried leaves of *T. polium* and *C. sinensis* using ultrasound-assisted extraction. Extracts were tested at 1%, 1.5%, and 2% concentrations for their total phenolic content (TPC) and antioxidant activity using the DPPH radical scavenging assay. Their antimicrobial properties were evaluated against common spoilage bacteria. Common carp fillets were treated with 0% (control), 1%, 1.5%, and 2% extract solutions and stored at 4°C for 20 days. Samples were analyzed every five days for pH, peroxide value (PV), thiobarbituric acid reactive substances (TBARS), total volatile basic nitrogen (TVB-N), and total viable count (TVC) of bacteria.

Results and Discussion The antioxidant activity assays demonstrated that the hydroalcoholic extracts of *Teucrium polium* and *Camellia sinensis* exhibited concentration-dependent effects, with the 2% (w/v) concentration showing the highest free radical scavenging capacity and reducing power. This enhanced activity can be attributed to the higher levels of polyphenolic compounds, which are well-documented for their hydrogen-donating and metal-chelating abilities, thereby effectively inhibiting lipid peroxidation. Similarly, antimicrobial evaluations revealed that the extracts exerted significant inhibitory effects against tested bacterial strains, with more pronounced activity observed against Gram-positive bacteria. This observation aligns with previous studies suggesting that Gram-positive bacteria are generally more susceptible to plant-derived phenolics due to the structural differences in their cell walls, which facilitate the penetration of bioactive compounds. During refrigerated storage at 4 °C, all extract-treated fillet samples exhibited slower rates of oxidative and microbial spoilage compared to the control group. The pH of treated fillets remained relatively stable throughout the 20-day storage period, whereas control samples displayed a gradual increase in pH, likely due to the accumulation of alkaline metabolites such as ammonia and amines produced by microbial proteolysis. PV and TBARS levels both indicators of lipid oxidation increased progressively in all samples over time. However, these increases were significantly lower in extract-treated samples, confirming the ability of the plant extracts to retard oxidative rancidity. Among treatments, the 2% extract concentration consistently produced the lowest PV and TBARS values, suggesting superior oxidative stability. TVB-N values, a key measure of protein degradation and freshness loss in fish, increased during storage in all groups. Nonetheless, treated samples, particularly those receiving 2% extract, exhibited significantly lower TVB-N values than controls, indicating delayed spoilage and extended freshness. Microbiological analysis showed that TVC and psychrotrophic bacterial populations were markedly reduced in treated fillets. The most pronounced microbial inhibition was observed in the 2% extract-treated samples, which maintained counts well below the generally accepted spoilage threshold (7 log CFU/g) throughout the storage period These results corroborate the antimicrobial potential of *T. polium* and *C. sinensis* extracts and suggest their promising application as natural preservatives in fish products.

Conclusion The results suggest that hydroalcoholic extracts of *T. polium* and *C. sinensis* are effective in enhancing the shelf life of common carp fillets by inhibiting lipid oxidation and microbial growth. The 2% extract concentration demonstrated the most pronounced effect. These natural plant extracts can serve as safe and effective alternatives to synthetic preservatives in fish preservation. Future research should explore their application in other seafood products and potential synergistic effects with other natural preservatives.

Keywords: Green tea, *Teucrium polium L.*, Carp fish, Storage

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