

Natural Antioxidants in Fish Preservation: The Role of *Salvia rosmarinus* Essential Oil

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With the growing demand for healthier and personalized foods, 3D food printing has emerged as a promising technique that offers customized composition, textures, and flavors in the production of various main dishes, snacks and desserts. However, several food safety concerns regarding the raw ingredients used in this technology still persist.

Gilt-head bream (*Sparus aurata*) is a marine fish species from the Sparidae family, is rich in docosahexaenoic (DHA) and eicosapentaenoic acids (EPA), making it a valuable dietary source of essential fatty acids. *Salvia Rosmarinus* (formerly *Rosmarinus officinalis*) is well known for its bioactive compounds such as rosmarinic acid, carnosic acid, carnosol, rosmariquinone, rosmanol, and rosmaridiphenol which have long been used in the food industry for their antioxidant properties. These compounds effectively neutralize free radicals formed during oxidation, offering a natural method for food preservation.

This study explores the potential of incorporating gilt-head bream into 3D-printed snacks while extending its shelf life through natural preservation with *Salvia rosmarinus* essential oil obtained via hydrodistillation. Minced fish samples were stored at 5 ± 1 °C for five days and treated with five different concentrations of *S. rosmarinus* essential oil (EO): T1 (0.075 µL/g EO), T2 (0.100 µL/g EO), T3 (0.150 µL/g EO), T4 (0.175 µL/g EO), and T5 (control, no EO). The quality of the fish was assessed using total volatile basic nitrogen (TVB-N) as an indicator of protein degradation. Results showed that the EO treatments, particularly at 0.150 µL/g (T3), significantly slowed protein breakdown, helping maintain freshness for a longer period.

In conclusion, *S. rosmarinus* essential oil shows strong potential as a natural preservative, offering a promising solution for extending the shelf life of fish-based ingredients used in 3D-printed foods.

Keywords: fish storage 3D print techniques; seafood shelf life; bioactive compounds in food; essential oils in food preservation of snacks; sustainable food preservation; omega-3 rich fish

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