Validation of active biopolymer packaging and its combination with high hydrostatic pressure for shelf-life extension of fishery products

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1 BACKGROUND

The environmental impact of plastic waste has become a critical global issue, with traditional food packaging contributing significantly to the accumulation of nonbiodegradable materials in landfills and oceans. This has spurred extensive research on sustainable alternatives that can replace conventional plastics without compromising the functionality essential for food preservation. The ideal substitute must not only be eco-friendly but also maintain or extend the shelf life of food products to reduce food waste.

2 OBJECTIVES

This study aimed to establish the effectiveness of an active biopolymer based on chitosan, olive leaf extract, and rosemary essential oil on the shelf life of tench (*Tinca tinca*) fillets and their combination with high hydrostatic pressures HHP.

1. Determining the increase in shelf life of tench fillets packaged in active biopolymers compared with traditional packaging.
2. Optimising High Hydrostatic Pressure treatments to reduce inoculated food pathogen populations in tench fillets packed in active biopolymers.

3 METHODS

1 Shelf life

- Packaging of tench fillets with and without active biopolymers.
- Storage at refrigerated temperature.
- Quantification of microorganisms at different times:
  - Total count (aerobic mesophilic).
  - *Enterobacteriaceae.*
  - Psychrophilic

2 HHP treatment

- *Salmonella enterica* sub. *enterica* (≈10^7 cfu·g^{-1}) inoculation.
- Packaging of tench fillets with active biopolymers.
- HHP treatment optimization by response surface methodology (RSM).
- Results validation.

4 RESULTS

Total count	Control	Active packaging	significance
1 day	5,39±0,22^{Ac}	3,51±0,27^{Bc}	****
5 days	7,85±0,21^{Ab}	3,98±0,18^{Bb}	****
10 days	8,79±0,18^{Aa}	4,88±0,20^{Ba}	****
significance	****	**	

Enterobacteriaceae	Control	Active packaging	significance
1 day	4,58±0,14^{Ac}	2,87±0,16^{Bc}	****
5 days	6,20±0,11^{Ab}	4,46±0,22^{Ba}	****
10 days	7,40±0,19^{Aa}	3,87±0,23^{Bb}	****
significance	***	***	

Psychrophilic	Control	Active packaging	significance
1 day	5,48±0,25^{Ab}	3,95±0,06^{Bc}	****
5 days	7,90±0,38^{Aa}	4,68±0,27^{Bb}	****
10 days	8,08±0,19^{Aa}	5,13±0,17^{Ba}	****
significance	***	***	

Table 1. Microbiological counts (log cfu·g^{-1}) of tench fillets packed with and without biopolymer (control) and stored under refrigeration (4 °C) for 10 days. The results are represented as the mean ±standard deviation of triplicate analyses. Upper-case letters indicate differences in the same row and lower-case letters indicate differences in the same column. ****p<0.0001, ***p<0.001, **p<0.01, *p<0.05.

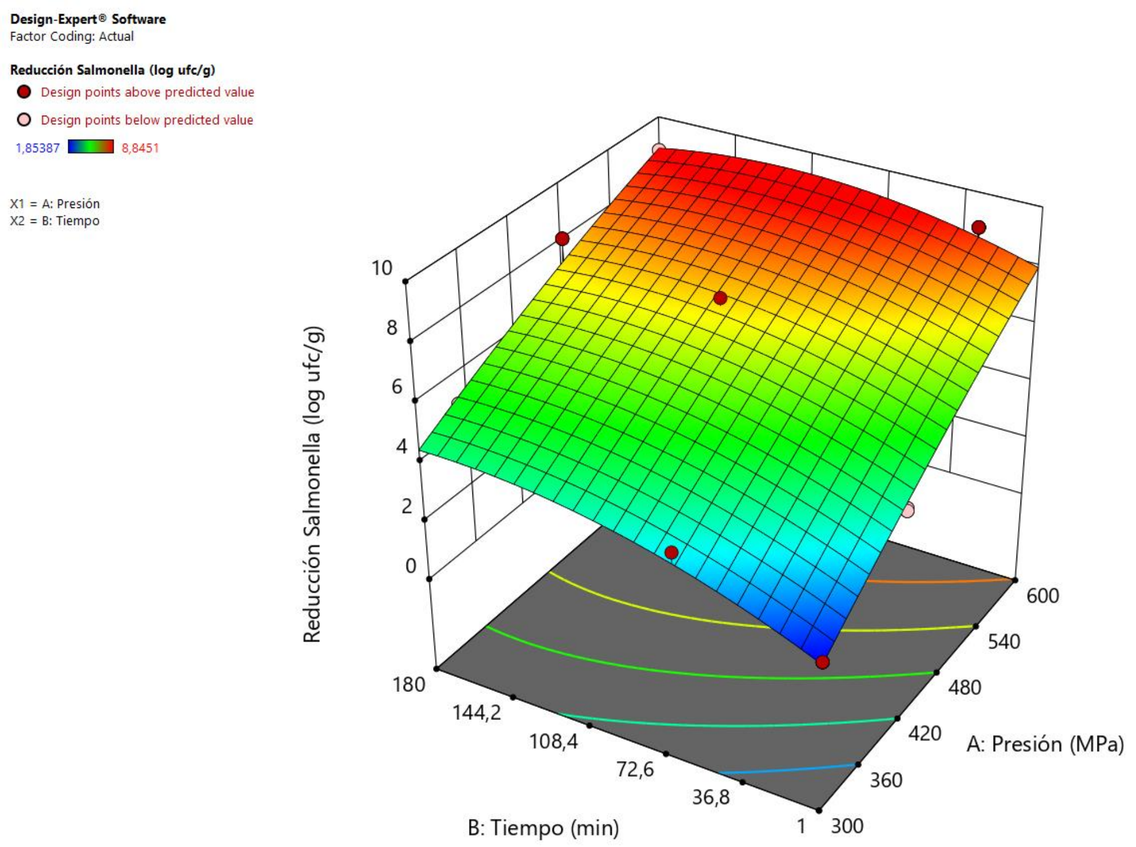

Figure 1. Predicted response surface model for *S. enterica* reduction using response surface methodology on tench fillets packed in active biopolymers and subjected to HHP treatment.

The results showed that packaging of the fillets increased the shelf life of the product by more than 10 days compared to traditional packaging. The packaging of tench in active biopolymers causes significant reductions in all the microorganisms analysed compared to traditional packaging, also reducing the rate of proliferation of these and, in the case of Enterobacteriaceae, decreasing their concentration over time.

Response surface analysis showed that for the effective reduction of *S. enterica* in fillets, treatments above 420 MPa or 108 seconds (reductions of 3 log cfu·g^{-1}) are necessary, with an optimum treatment of 600 MPa for 27.85 seconds a maximum reduction.

5 CONCLUSIONS

Our findings indicate that the combination of high hydrostatic pressure and packaging in active biopolymers decreases the initial microbiology and ensures that good conditions for consumption are maintained over time. The development and application of these sustainable packaging solutions are essential to achieve a circular economy in the food industry, ultimately contributing to environmental conservation and food safety.

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