Lipid Oxidation Inhibition in Frozen Farmed Salmon (*Oncorhynchus kisutch*): Effect of Packaging

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Abstract: Coho salmon (*Oncorhynchus kisutch*) has recently attracted a great interest as a farmed product. This research focuses on its commercialisation as a frozen product. For it, an advanced storage technology combining vacuum and a polyphenolic rich-film was applied for a 9-months storage period (–18°C). The study was addressed to lipid hydrolysis and oxidation changes and to endogenous antioxidant content in salmon muscle. No effect of packaging conditions could be observed on free fatty acid formation. However, vacuum packaging conditions provided a partial inhibition of primary (peroxide) and secondary (anisidine value) lipid oxidation development; this inhibitory effect was accompanied by a lower tocopherol isomers loss. The employment of a film including polyphenolic compounds led to a partial inhibition of α-tocopherol breakdown and to a lower secondary (anisidine value) and tertiary (fluorescent compound formation) lipid oxidation development. A partial inhibitory effect on lipid oxidation development is concluded for the employment of a polyphenolic compound rich-film packaging when applied to farmed coho salmon.

Keywords: coho salmon; packaging; antioxidant; frozen storage; rancidity

INTRODUCTION

Freezing and frozen storage of fish have largely been employed to retain sensory quality and nutrients. However, fish species with both highly unsaturated lipid composition and prooxidant molecules can suffer an important rancidity development and quality loss (Erickson 1997). Among the different recent treatments tested to enhance lipid oxidation stability during the frozen storage, employment of vacuum packaging and films including preserving plant extracts is actually supporting an important role (Vermeiren *et al.* 1999).

In recent years, the fishing sector has suffered from dwindling stocks of traditional species. This has prompted the fish trade to pay more attention to aquaculture development as a source of marine food products (Stickney 1990). One of such species is coho salmon (*Oncorhynchus kisutch*). The present work focuses on the lipid damage development of this farmed species during frozen storage conditions; the employment of an advanced packaging technology is tested in order to enhance the product quality.

MATERIAL AND METHODS

A polyphenolic (ferulic and p-coumaric acids, namely) rich-film and vacuum packaging was applied. Thus, vacuum packaging was combined to three plant extract additations (0, 50, and 100 mg extract/ml; P1, P2, and P3 conditions, respectively) and compared to frozen fish control (C condition). Coho salmon individuals (50–52 cm length; 2.8–3.0 kg weight) were obtained from an aquaculture facility. For each packaging condition, three different batches were considered and analysed separately (n = 3).

Table 1. Evolution of different lipid parameters in farmed salmon kept frozen under different packaging conditions*

Lipid parameter	Time (months)	Packaging condition			
		C	P1	P2	P3
Free fatty acid content	0	1.60 (0.38)	1.60 (0.38)	1.60 (0.38)	1.60 (0.38)
	3	4.05 (0.75)	2.61 (0.76)	1.86 (0.23)	5.10 (0.90)
	9	6.18 (0.10)	5.79 (1.08)	4.06 (1.37)	6.60 (0.76)
Peroxide value	0	3.81 (1.67)	3.81 (1.67)	3.81 (1.67)	3.81 (1.67)
	3	5.97 (0.60)	4.03 (1.44)	2.86 (0.70)	4.29 (1.58)
	9	25.69 (18.03)	5.72 (4.54)	4.48 (0.47)	4.64 (1.23)
Anisidine value	0	0.84 (0.58)	0.84 (0.58)	0.84 (0.58)	0.84 (0.58)
	3	1.63 (0.43)	2.09 (1.09)	1.89 (0.62)	1.79 (0.73)
	9	4.20 (0.83)	2.31 (0.93)	1.52 (0.38)	1.06 (0.60)
Fluorescent compound formation	0	1.32 (0.04)	1.32 (0.04)	1.32 (0.04)	1.32 (0.04)
	3	1.04 (0.06)	1.23 (0.25)	1.16 (0.04)	1.04 (0.16)
	9	1.31 (0.14)	1.44 (1.00)	1.21 (0.25)	0.97 (0.15)
Alpha-tocopherol content	0	11.41 (0.98)	11.41 (0.98)	11.41 (0.98)	11.41 (0.98)
	3	8.37 (2.33)	10.33 (0.85)	11.61 (2.02)	12.74 (3.29)
	9	7.19 (1.76)	9.70 (0.65)	11.88 (3.08)	13.78 (2.52)
Gamma-tocopherol content	0	8.04 (1.20)	8.04 (1.20)	8.04 (1.20)	8.04 (1.20)
	3	6.36 (1.52)	9.47 (2.27)	8.92 (0.67)	10.75 (1.15)
	9	5.42 (1.65)	9.25 (0.73)	9.94 (1.93)	10.49 (1.41)

*Mean values of three (n = 3) independent determinations are expressed. Standard deviations are indicated in brackets. Packaging condition abbreviations as expressed in the Material and Methods section

Lipid hydrolysis and oxidation and endogenous antioxidant content were studied on fish muscle up to 9 months of frozen storage (–18°C).

Lipid extraction was carried out according to the Bligh and Dyer (1959) method. Free fatty acid (FFA) content was determined by the Lowry and Tinsley (1976) method; results are expressed as g FFA/100 g lipids. The peroxide value (PV) was determined according to Chapman and McKay (1949); results are expressed as meq active oxygen/

kg lipids. The anisidine value (AV) was determined according to the AOCS (1993) method. Fluorescent compound formation was analysed according to Aubourg *et al.* (1997). Tocopherol isomers (alpha and gamma) content was determined by HPLC according to Cabrini *et al.* (1992); results are expressed as mg/kg muscle.

Data were subjected to statistical analysis ($P < 0.05$) to explore significant differences as a result of packaging conditions and frozen storage time (SPSS Inc., Chicago, Il, USA).

RESULTS (Table 1)

For all kinds of samples, an important lipid hydrolysis and oxidation development could be depicted according to the evolution of the different quality indices related to lipid damage. It is concluded that endogenous enzymes (hydrolytic and oxidative) are still active under the present storage conditions (Sikorski & Kolakowski 2000).

No effect of packaging conditions could be observed on FFA formation; some differences among samples could be observed and mostly explained as a result of an important effect fish-to-fish differences.

However, vacuum packed fish (P1, P2, and P3 conditions) provided a partial inhibition of primary (peroxide) and secondary (AV) lipid oxidation development; this inhibitory effect was accompanied by a lower tocopherol isomers loss. Accordingly, a protective effect of vacuum packaging is concluded, in agreement to previous research carried out on related fish species (Sivertsvik *et al.* 2002).

Finally, the employment of a film including polyphenolic compounds (P2 and P3 conditions) led to a partial inhibition of α-tocopherol breakdown and to a lower secondary (AV) and tertiary (fluorescent compound formation) lipid oxidation development. In this sense, interaction compound formation (tertiary lipid oxidation) has been shown to be responsible for important nutritional and sensory value losses during the frozen storage of fish species (Pokorný 1981; Mackie 1993). A partial inhibitory effect on lipid oxidation development is concluded for the employment of a phenolic rich-film packaging when applied to farmed coho salmon.

Acknowledgements. This research was carried out in the frame of the Project No. 2006 CL 0034 (2007–2008), granted by the U. Chile-CSIC Cooperation Program. Coho salmon fish was provided by Aquachile SA (Puerto Montt, Chile).

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