SKIN FISH OIL AS POTENTIAL SOURCE OF OMEGA-3 FATTY ACIDS FOR ADDITION TO FUNCTIONAL MEAT PRODUCTS: DETERMINATION OF OXIDATIVE STABILITY

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Introduction

The meat industry must adapt to the new concepts in nutrition. Functional meat products constitute an opportunity for achieving a healthy and balanced diet and a higher diversification in the sector. A food can be regarded as 'functional' if it is satisfactorily demonstrated to affect beneficially one or more target functions in the body, beyond adequate nutrition, in a way that improves health and well-being or reduces the risk of disease. One of the effects of these foods is associated with inhibiting the absorption of cholesterol, which is thought to be a major factor in cardiovascular disease. A number of ingredients, including omega-3 fatty acids, possess this property. Lipids from nonmeat sources (e.g., vegetable and fish oils) could be used to improve fatty acid profiles of meat products. With this aim, various different vegetable oils have been used in normal and low-fat meat products. In a previous work (Broce et al., 2005), part of the animal fat was replaced by several vegetable oils (sunflower, canola, olive) in low-fat frankfurters to achieve a healthier product. However, although the content of saturated fatty acids decreased and unsaturated fatty acids increased, the ratio omega-6/omega-3 was too high to be nutritionally correct. Other strategy is direct addition of fish oils (high content of omega-3 fatty acids) to frankfurters. This work is a preliminary study to evaluate the stability against oxidation of oils extracted from fish skin. The oxidation of orange roughy oil was evaluated by a number of complementary methods. The oil was exposed to pro-oxidative conditions during storage for comparison with conventional storage under refrigeration.

Materials and Methods

Raw material: The raw material was orange roughy (*Hoplostethus atlanticus*) skin provided by Pescanova, a Spanish food company. Frozen fish skin was cut into small pieces (2-5 mm equivalent average diameter) with a cutter (CT25, Talleres Cato S.A. Spain), freeze-dried and fat extracted with supercritical carbon dioxide at 25 MPa and 40 ºC. Fish oil was analysed immediately after extraction (day 0) and at day 7 and 14 of storage under pro-oxidative conditions (20 ºC, sunlight, presence of O_2), and conventional conditions (4 ºC, without light and under inert atmosphere).

Fatty acid analysis: Fatty acids were methylated and analysed by gas chromatography according to the AOAC method on a Hewlett Packard gas chromatograph (6890 N Network GC System). A fused silica capillary column (Omegawax^{TM}-320, 30 m ´ 0.32 mm i.d.) was used. Fatty acid methyl esters were identified by comparison of their retention times with those of chromatographic standards (Sigma Chemical Co.). Their quantification was made by relating the peaks area to the area of an internal standard (methyl tricosanoate) as indicated by the AOAC method.

Hexanal determination: Solid Phase Dynamic Extraction (SPDE) (Chromtech, Idstein, Germany) was performed after equilibration of samples at 70 ºC for 1 min. The SPDE needle was inside coated by PDMS-AC. Gas chromatographic analyses were carried out with an Agilent Technologist 6890N Series GC System coupled to an Agilent Technologist 5973i mass spectrometer (Agilent Technologist, Palo Alto. CA.USA). Sample desorption of from he SPDE syringe was carried out at 250 ºC. Compounds were separated on a HP5 capillary column (50 m length x 0.32 mm I.D fused silica capillary column coated with 1.05 mm film thickness (Quadrex Corporation. New Haven. USA)). The temperature of the column was increased at a rate of 3 ºC/min from 40 to 240 ºC. The effluent from the capillary column went directly into the mass spectrometer and hexanal was identified comparing its mass spectra with NIST and Wiley spectrum libraries.

Odour profile analysis by e-nose: The analyses were performed by an electronic nose αFOX 4000 (AlfaMOS, Toulouse, France) with a sensor array of 18 metal oxide sensors. The vials with samples were incubated under agitation (cycles 5 s on and 2 s off and 500 rpm) in an oven at 50 ºC for generating the equilibrated headspace. The injection temperature was 60 ºC, the carrier gas was synthetic air with a flow of 150 ml/min.

Stability analysis: Four different tests were performed along fourteen days: determination of free fatty acids (FFA)(AOCS, 1994), peroxide value (PV)(AOCS, 1994), anisidine index (AV)(BSI, 1998) and totox value (TX).

Results and Discussion

The fatty acid profile of the extracts under different conditions of storage was determined. Storage time slightly influenced the proportion of saturated fatty acids that increased at day 14 and mono and polyunsaturated fatty acids, which decreased after this time of storage. Oil stored under different conditions did not differ at any time.

Table 1. Influence of the storage conditions on the fatty acid profile of orange roughy oil

Fatty acid	Temperature 4 ºC			Temperature 20 ºC		
(mg/g oil)	day 0	day 7	day 14	day 0	day 7	day 14
C14:0	4.1	3.8	3.1	4.1	3.7	3.1
C16:0	5.9	5.6	5.9	5.9	5.4	5.7
C18:0	3.1	5.3	17.4	3.1	9.2	20.7
Saturated	13.0	14.8	26.3	13.0	18.3	29.5
C16:1	44.5	43.2	34.0	44.5	41.8	34.7
C18:1	234.8	237.7	194.3	234.8	235.3	192.3
C20:1	54.0	62.4	45.1	54.0	70.0	46.8
C22:1	18.9	29.6	13.1	18.9	37.7	13.4
Monounsaturated	352.2	372.9	286.6	352.2	384.7	287.2
C18:2	7.1	7.3	3.7	7.1	6.8	4.1
C18:3n3	1.2	1.4	0.8	1.2	1.4	0.7
C20-4	1.7	1.4	1.2	1.7	1.3	1.4
C20:5n3	5.6	3.7	2.9	5.6	3.2	2.8
C22:5n3	1.2	0.8	0.7	1.2	0.7	0.7
C22:6n3	13.1	27.0	5.6	13.1	40.4	5.8
Polyunsaturated	29.9	41.6	14.9	29.9	53.8	15.4

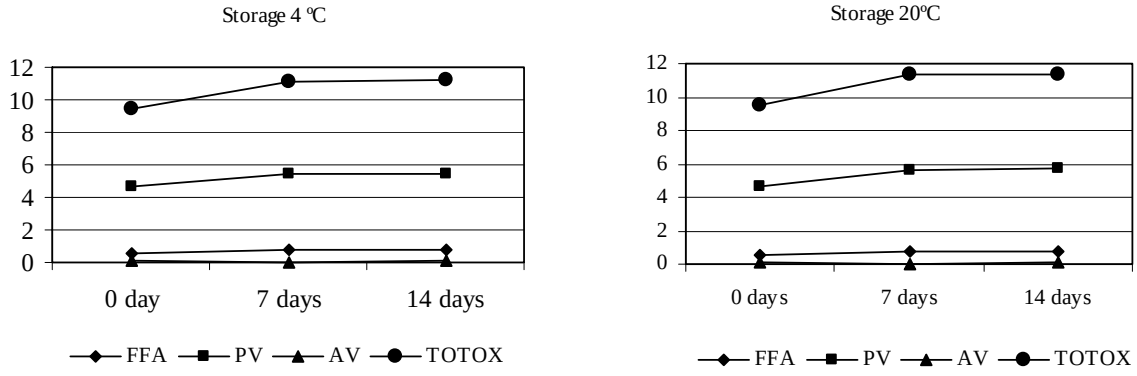

Figure 1. Evolution of percentage of free fatty acid (expressed as oleic acid), peroxide value (meq O_2/kg sample), anisidine value and totox value along storage.

PV, AV and TV increased from day 0 to day 7 and then they kept unchanged until day 14, but the storage conditions did not affect them. Hexanal content increased with the time and temperature, and e-nose odour profile also suffered modifications by time and storage conditions.

Conclusions

The orange roughy oil presented a good stability against oxidation, however volatile compounds experimented modifications along 14 days of storage under refrigeration enhanced by high temperature. Longer periods of time should be studied to definitely state such stability features.

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