

Stability of Fish Oil against Oxidation characterized by Chemiluminescence and Differential Isoconversional Kinetic Analysis.

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ABSTRACT

Fish oil is recommended for a healthy diet because it contains the omega-3 fatty acids, eicosapentaenoic acid (EPA, 20:5(n-3)), and docosahexaenoic acid (DHA, 22:6(ω -3)), precursors to eicosanoids that reduce inflammation and anti cancer effects throughout the body. Fish do not actually produce omega-3 fatty acids, but instead accumulate them from either consuming microalgae that produce these fatty acids, as is the case with fish like herring and sardines, or, as is the case with fatty predatory fish, by eating prey fish that have accumulated omega-3 fatty acids from microalgae. Such fatty predatory fish like mackerel, lake trout, flounder, albacore tuna and salmon may be high in omega-3 fatty acids, but due to their position at the top of the food chain, these species can accumulate toxic substances. For this reason, the FDA recommends limiting consumption of certain (predatory) fish species (e.g. albacore tuna, shark, and swordfish) due to high levels of toxic contaminants such as mercury, dioxin, PCBs and chlordanes. There are vegetarian, DHA Omega-3 products made from algae available if toxic contaminants are of concern.

Some experts believe that taking fish oil (in any form) can help regulate cholesterol in the body, because fish oil has high levels of omega-3 fatty acids. The regulation occurs through effects of the EPA and DHA constituents on Peroxisome proliferator-activated receptor alpha (PPAR α).

Dietary DHA may reduce the risk of heart disease by reducing the level of blood triglycerides in humans. Low levels of DHA result in reduction of brain serotonin levels and have been associated with ADHD, Alzheimer's disease, and depression, among other diseases, and there is mounting evidence that DHA supplementation may be effective in combating such diseases.

In this study, we report the results of testing the stability of fish oil against oxidation including the quantification of kinetic parameters. Fish oil from small deep-sea fish originating from the clean waters around Antarctica was tested. The samples tested are commercial supplements protected by Vitamin E and with varying EPA:DHA ratio (Table 1). All samples are pharmaceutical grade, purified with a patented CO₂ distillation process (hexane free) to remove heavy metals, dioxins and pesticides.

	saturated	unsaturated	Omega-3	EPA	DHA	Vitamin E
Sample A	2.4%	62.5%	44.0%	25.7%	12.2%	0.34%
Sample B	0.3%	57.3%	51.5%	39.8%	5.5%	0.27%
Sample C	0.0%	55.2%	48.8%	5.2%	37.7%	0.52%
Sample D	1.8%	58.6%	49.8%	38.4%	5.3%	0.58%
Sample E	0.0%	73.7%	68.7%	65.2%	0.0%	1.30%

Table 1: Fish oil samples tested with concentration of unsaturated, saturated fatty acids and Vitamin E.

The data acquisition of fish oil oxidation was performed under isothermal conditions from 60°C to 80°C (Figure 1) in synthetic air with a single channel basic Chemiluminescence configuration from ACL Instruments Inc. (www.aclinstruments.com/en/).

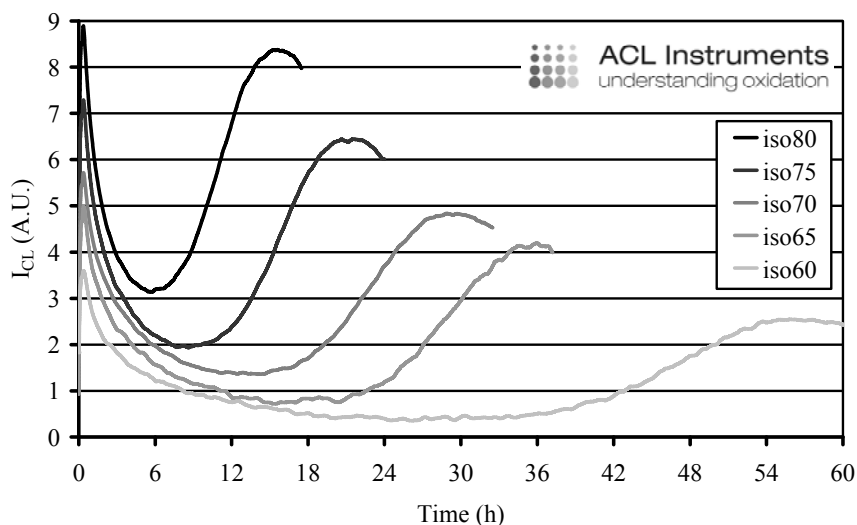


Figure 1: Example of fish oil oxidation followed with Chemiluminescence (sample A). The sample consists of 44% omega-3 fatty acids with EPA:DHA ratio = 2.107:1 and 0.34% Vitamin E.

The end of antioxidant effectiveness results in characteristic change in the CL-curves. Kinetic parameters were calculated applying simple Arrhenius linearization for the times up to the end of antioxidant activity (activation energy for the event Oxidation Onset) and by applying differential isoconversional analysis (activation energy as a function of the oxidation process). Isoconversional kinetic analysis was performed using the AKTS-Thermokinetics software V3.00 (www.akts.com/).

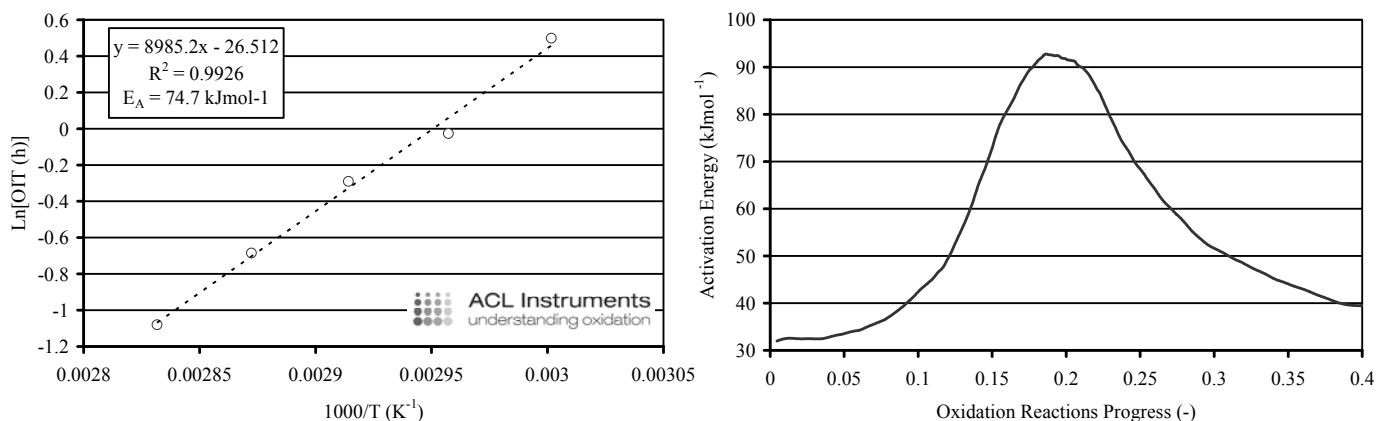


Figure 2: Activation energy parameters of fish oil oxidation (sample A) calculated by linear regression of the oxidation onset events (left hand) and calculated with differential isoconversional method (AKTS-Thermokinetics software V3.00: right hand) of the first 40% of oxidation reaction progress.

The kinetic parameters of the oxidation process, calculated from the Chemiluminescence's signals by means of the differential isoconversional method of Friedman, are subsequently applied for the simulation of the fish oil oxidation under different storage temperature profiles to assess the life time of fish oil products and supplements.