APPLICATION OF MICROANALYTICAL CHEMILUMINESCENCE FOR DETERMINATION OF THE FISH OIL STABILITY IN OXIDATIVE ATMOSPHERE.

KÄSER Fabian[*,**], RODUIT Bertrand[***]

[*] *ACL Instruments AG, Industriestr. 11, 3210 Kerzers, Switzerland,*
email address: fabian.kaeser@aclinstruments.com

[**] *Berne University of Applied Sciences, Fellerstr. 11, 3027 Bern, Switzerland*

[***] *AKTS AG Advanced Kinetics and Technology Solutions, TECHNOArk 3, 3960 Siders, Switzerland,* email address: b.roduit@akts.com

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 chlordane. 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 (PPARα).

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 the first part of this study, we report the stability and quality testing of fish oil against oxidation including the calculation of simple kinetic analysis by the linear regression linearization of the oxidation induction time (OIT) events. The second part of this study deals with the data analysis by means of the differential isoconversional method and the subsequent application of the results for the simulation of the fish oil oxidation under different storage temperature profiles to assess the life time of fish oil products and supplements.

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 CO_2 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 AG (www.aclinstruments.com/en/). Specific Experiments were tested with the microcalorimetric method at the same conditions.

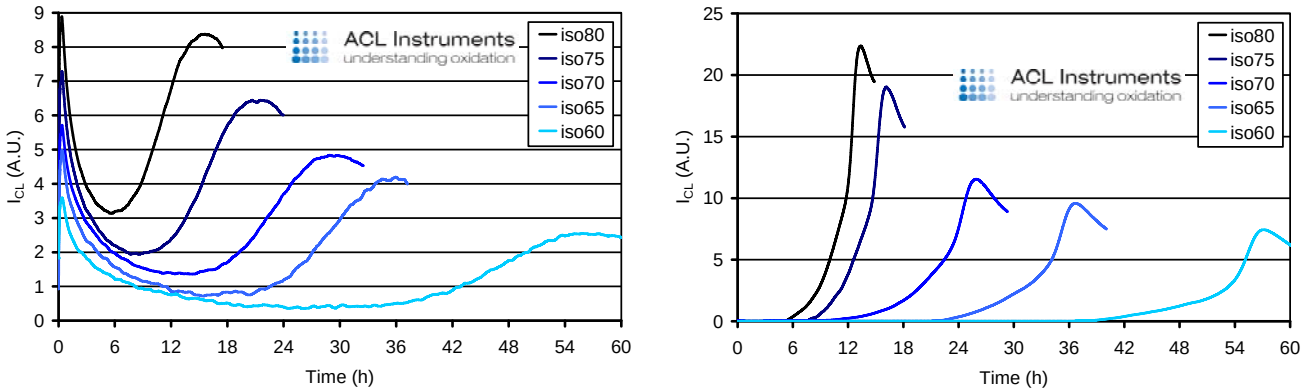

Figure 1: Fish oil oxidation followed with Chemiluminescence: sample A (left hand side) and sample E (right hand side). It is obvious that there are significant differences between the different samples: e.g. high amounts of hydroperoxides accumulated in sample A (CL-intensities at the beginning of the experiments before the oxidation starts) and no ROOH in sample E.

The end of antioxidant effectiveness of the vitamin E additive results in characteristic change in the CL-curves. Simple kinetic parameters were calculated applying the Arrhenius linearization approach for the OIT events (activation energy for the event Oxidation Onset).

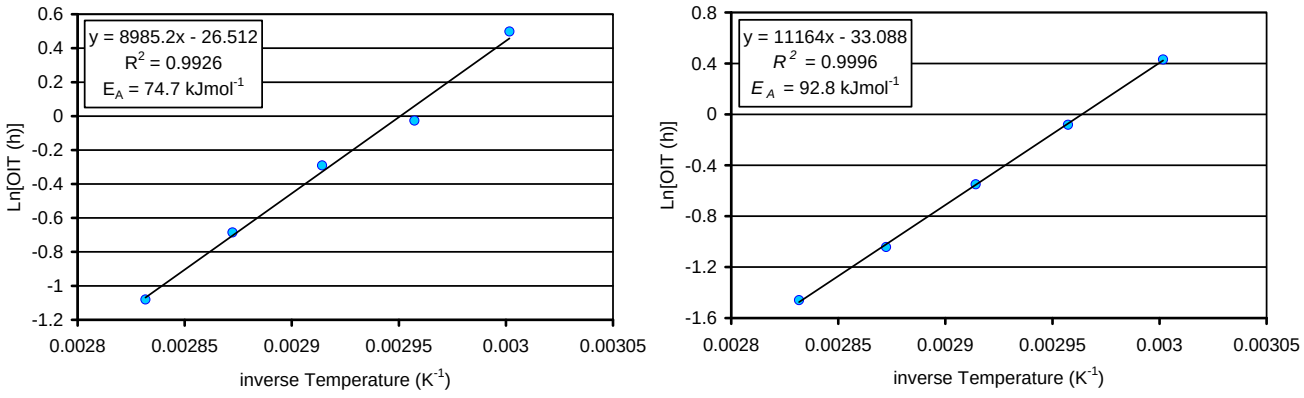

Figure 2: Linearization of the activation energy parameters of fish oil oxidation onset events in the Arrhenius diagram (sample A at the left hand side, sample E at the right hand side).