

***NMR studies of fish and fish products
with emphasis on industrial challenges.***

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Today, both fisheries and aquaculture are focusing on freshness and high product quality, in addition to the fact that marine raw materials contain components with great dietary benefits for human health. One of the most important industrial challenges is to be able to keep up the quality through the whole value chain. It is necessary to develop basic knowledge about the product composition, its degradation processes, effect of processing on product and preservation quality. There is a lot of on-going research in this field today, where both traditional and more sophisticated techniques are used. However, modern nuclear magnetic resonance techniques open up possibilities to study food stuff non-destructively and non-invasively.

Low field NMR techniques are proved to be useful in the process and quality control. It has been demonstrated that a newly developed time domain NMR technique allow determining the most important quality parameters of fish feed as protein, fat and moisture content in one measurement. To day this method is implemented as an at-line method at several fish feed production plants. Furthermore, the low field techniques provide information about the fat and protein in fish tissue, and a combination of free induction decay and a pulsed gradient spin-echo technique allows simultaneous determination of fat and water content in fatty fish species. Structural changes in fish muscle, water binding and distribution within the muscle can be studied by low field NMR. Low field NMR has a great potential as a non-invasive method for measuring important quality attributes.

High resolution NMR is demonstrated to be a unique tool in lipid research where many metabolites or components can be studied simultaneously in relatively short time without any extraction involved, revealing a global picture of the sample. It is possible to quantify lipid classes, fatty acid composition, to study the positional distribution of the fatty in the triacylglycerol molecule, to study the lipolysis and lipid oxidation in the same sample. Furthermore, the HR NMR spectrum is a fingerprint that can be used in origin testing and verification of traceability data.

¹H high resolution magic angle spinning (MAS) NMR can be used to quantify the total omega-3 fatty acids in intact muscle of salmon or to study changes in muscle metabolites due to farming regimes etc.

Magnetic resonance imaging (MRI) is mainly used in food science as a research tool. Due to high investment costs, the sheer size of the instrument and infrastructure needed, MRI cannot presently be considered as a standard analytical tool in aquaculture or fish processing industry. However, as a research tool taking advantage of the unique features of the method, we can obtain unique basic insight into a number of issues related to anatomical studies, composition and structure of tissues, distribution maps of fat, water and salt as well as temperature profiles of the samples. Theoretical transport models can often be used to interpret the images. For the industry MRI studies can be helpful in studying of the effect of feeding regimes during on-growth phase or fish processing, optimisation of unit operations in the fish processing such as salting, freezing and thawing.